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Exploring Undergraduate Disciplinary Writing: Expectations and Evidence in Psychology and Chemistry

Katherine E. Moran
Georgia State University

EXPLORING UNDERGRADUATE DISCIPLINARY WRITING: EXPECTATIONS AND EVIDENCE IN PSYCHOLOGY AND CHEMISTRY

by

KATHERINE E. MORAN

Under the Direction of Viviana Cortes

ABSTRACT

Research in the area of academic writing has demonstrated that writing varies significantly across disciplines and among genres within disciplines. Two important approaches to studying diversity in disciplinary academic writing have been the genre-based approach and the corpus-based approach. Genre studies have considered the *situatedness* of writing tasks, including the larger socio-cultural context of the discourse community (e.g., Berkenkotter & Huckin, 1995; Bhatia, 2004) as well as the move structure in specific genres like the research article (e.g., Swales, 1990, 2004). Corpus- based studies of disciplinary writing have focused more closely on the linguistic variation across registers, with the research article being the most widely studied register (e.g., Cortes, 2004; Gray, 2011). Studies of undergraduate writing in the disciplines have tended to focus on task classification (e.g., Braine, 1989; Horowitz, 1986a), literacy demands (e.g.,Carson, Chase, Gibson, & Hargrove, 1992), or student development (e.g., Carroll, 2002; Leki, 2007).

The purpose of the present study is to build on these previous lines of research to explore undergraduate disciplinary writing from multiple perspectives in order to better prepare English language learners for the writing tasks they might encounter in their majors at a US university. Specifically, this exploratory study examines two disciplines: psychology and chemistry. Through writing task classification (following Horowitz, 1986), qualitative interviews with faculty and students in each discipline, and a corpus-based text analysis of course readings and upper-division student writing, the study yielded several important findings. With regard to writing tasks, psychology writing tasks showed more variety than chemistry. In addition, lower division classes had fewer writing assignments than upper division courses, particularly in psychology. The findings also showed a mismatch between the expectations of instructors in each discipline and students' understanding of such writing expectations. The linguistic analysis of course readings and student writing demonstrated differences in language use both between registers and across disciplines.

INDEX WORDS: Writing in the disciplines, Undergraduate writing, Multi-dimensional analysis, Reading-writing relationship, Writing expectations, Academic genres

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KATHERINE E. MORAN

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KATHERINE E. MORAN

Committee Chair: Viviana Cortes

Committee: Diane Belcher

Ericson Friginal

George Pullman

Electronic Version Approved:

Office of Graduate Studies

College of Arts and Sciences

Georgia State University

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DEDICATION

To Mustafa and Zahra

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1 INTRODUCTION

Universities and colleges throughout the United States have thriving English language programs aimed at teaching international students the language skills they will need to navigate mainstream university curriculum. Many of these programs teach English for academic purposes, or EAP, an area of applied linguistics and TESOL that has received a lot of attention over the past two decades. However, there seems to be little empirical evidence in the form of needs analysis done to determine the content and curricular goals of such programs. Though research has been done to examine the writing practices within and across disciplines at the university level over the past twenty years, the investigations have followed vastly different methodologies, making definitive knowledge of what undergraduate writing entails in terms of faculty and departmental expectations as well as what undergraduate writing actually looks like, a difficult practice at best. As Carson, Chase, Gibson & Hargrove (1992) argue, programs designed to prepare students for university study, "must be tied directly to the content and practices of a university curriculum" (p. 26).

Research traditions govern research and writing for various disciplines, creating a form of language that marks an insider or expert in the field from an outsider or a novice (Hyland, 2009; Wenger, 1998). This, in turn, affects the types of writing done by faculty in various departments as well as the types of writing they require from their students. Carstens (2008), for example, found that academic essays were favored in the humanities in her study of preferred rhetorical modes in humanities and social sciences, while Jackson et al.(2006)found laboratory reports the most frequently assigned genre in undergraduate science courses.

Becoming acclimated to the rhetorical styles and writing expectations of different disciplines is something students must learn to gain membership in the academic community (Bizzell, 1986; Carroll, 2002; Harris, 1989; Hyland, 2009; Leki, 2007). Writing in the disciplines is likely very different from the

writing students may be accustomed to from their high school or freshman composition courses, which often have a focus on narrative essays, creative writing and perhaps a highly generic version of academic writing. The correlation between success in freshman composition and successful writing in the disciplines is unclear. As Carroll (2002) points out, some students in her study were quite successful in writing for their major courses yet continued to have difficulty with the more creative and less structured types of writing assignments often required by their general education writing classes.

Though it is unlikely, and perhaps unrealistic, that professors expect undergraduate students to produce journal-quality writing, the research article published in a peer reviewed journal is generally accepted as the most prestigious form of academic writing and likely the discourse type faculty consider a model of the rhetorical style for their discipline (Hyland, 2009). Historically, the conventions of the research article developed from a need to create a language of science that distinguished it from vernacular language use(Halliday & Martin, 1993). Through the evolution of scientific writing, the use of nominalizations developed; one example of a widely recognized feature of academic writing (Biber, Johansson, Leech, Conrad, & Finegan, 1999; Hyland, 2009; Robinson, Stoller, & Jones, 2008).

The research article may represent the model form of writing for a particular discipline; however, it is unclear how much exposure undergraduate students have to this type of writing. Previous research shows that undergraduates are primarily reading books (geared for a general audience) or textbooks in disciplines in both the physical and social sciences (Carson et al., 1992; Conrad, 1996). Though it is known that academic writing varies widely across the disciplines, little is known about the variations of this type of language production at the undergraduate level.

The present study will explore undergraduate writing in psychology and chemistry; disciplines chosen for several reasons. First of all, the core curriculum for an undergraduate degree in the United States typically requires students to take courses in social sciences as well as physical sciences. While chemistry is inarguably a physical science, psychology, as a discipline, is oriented toward both empirical

and theoretical research. Methodologies followed in psychology include both quantitative and qualitative analyses. These disciplines are also frequently chosen as majors for undergraduate students as they encompass a wide range of possible careers and form a solid foundation for many more specialized fields of study.

This study will begin by examining the writing tasks required in chemistry and psychology courses at each level of undergraduate study. Categorizing the writing tasks according to type will show what students are being asked to produce throughout a course of study in these departments. Further inquiry into the expectations of students as writers through surveys and interviews will reveal more about how faculty believe students learn to write for the field and what their goals and expectations are of student writers at different levels of study. Furthermore, talking to students majoring in each of these disciplines can give insight into their experiences as student writers and allow them to discuss the challenges of becoming effective writers. To more fully explore undergraduate writing, the reading materials that students are exposed to throughout their course of study will be analyzed to form a basis of comparison with the actual writing they produce. Finally, an analysis of student writing samples from the upper division courses of chemistry and psychology will provide a picture of what student writing ultimately looks like as majors in each discipline complete their degrees.

In order to explore these areas, the present study aims to answer the following research questions:

1. How much and what type of writing are undergraduate students expected to do at each course level (1000-4000) in Psychology and Chemistry?
2. What are faculty expectations of undergraduate student writers at each level of study? What are students' experiences learning to write for their discipline and of their instructors' writing expectations?
3. What types of writing are undergraduate students exposed to through their course readings throughout their academic careers in Psychology and Chemistry?
4. What is student writing like at the highest levels of undergraduate study in Psychology and Chemistry and how does it compare to the writing they were exposed to through course readings?

This dissertation will be organized in the following manner. Chapter 2 reviews the literature related to the present study in the areas of academic writing and disciplinary variation in writing, the classification of writing tasks, instructors' expectations and students' experiences with undergraduate writing, the connection between reading and writing tasks, and an overview of studies of linguistic variation by register using multi-dimensional analysis. Chapter 3 describes the methodology of the study beginning with the methods for data collection, followed by the methods of analysis for each section. Chapters 4 through 6 present the findings of the study. Chapter 4 provides the findings for the classification of writing tasks in the focal courses in chemistry and psychology. A discussion of the themes discovered through the interviews with instructors and students is presented in Chapter 5. Chapter 6 focuses on the results of the multidimensional analysis of the course readings and student writing. The concluding chapter, Chapter 7, summarizes the major findings of the study and discusses the pedagogical implications of the study as well as avenues for future research.

2 LITERATURE REVIEW

By exploring instructors' expectations and student experiences through qualitative interviews, as well as looking at assignment prompts, course readings and student writing through quantitative text analysis, the present study integrates several approaches to researching academic writing in the disciplines. Though it seems that few, if any, previous studies of writing in the disciplines have used this same integrative approach, studies in the areas of academic writing and writing in the disciplines have laid the groundwork for the study presented here. There have been studies written regarding the diversity of academic writing across disciplines, how students learn to write for disciplines and what teachers expect from student writing. Each study, however, seems as though it may be missing a component of the picture. Studies of linguistic variation across disciplines give insight into lexico-grammatical patterning differences within and between disciplines, and have demonstrated both the similarities and dissimilarities between comparable texts produced in different disciplines. Results have illustrated that the differences are often patterned, yet counter-intuitive. These studies, however, provide little information about the writers or the audience. On the other hand, studies exploring student development as writers have given insight into the students' experiences and often include the instructors' perspectives, and have shown that students become aware of genre differences in their different courses, but often have difficultly deciphering instructors' expectations. Instructors, on the other hand, are not always aware of the disciplinary orientation of their expectations of writers. Such studies, though, do not look at what these students are reading and writing from a linguistic standpoint. The present study aims to complete the picture by marrying a qualitative exploration of instructors' expectations and students' experiences, and a quantitative linguistic analysis of student produced texts and course readings.

This chapter will describe the literature relevant to the present study in the areas of academic writing and diversity of academic writing in the disciplines, disciplinary writing tasks and expectations, students' experiences as writers, and briefly, work conducted in the area of reading and writing and

their inter-relationship. The final section will describe the methodology of multi-dimensional analysis as well as studies that have used this methodology in order to explain why this method of analysis was chosen to examine the linguistic features of the course readings and student writing in this study.

2.1 Academic writing and diversity of academic writing in the disciplines

As Hyland (2000) states, "There is…a clear consensus on the importance of written texts in academic life – a recognition that understanding the disciplines involves understanding their discourses" (p.2). Academic writing is, at the broadest scope, the written discourses of the academy. It is the means and the language through which scholars transmit ideas and construct knowledge. In fact, the broader term *academic discourse* is probably more accurate, for in order to produce academic writing one must be engaged in the discourse of the academy, which, according to Gee(1996) goes beyond language and involves, "ways of behaving, interacting, valuing, thinking, [and]believing" (p. viii) in addition to speaking, reading and writing. Similarly, Berkenkotter and Huckin (1995) view discursive acts as emblematic of genre knowledge and situated within disciplinary activities. The attempt to distill the complexity of academic discourse into a skill set that can be taught and learned (such as *academic English)* follows what Hyland (2009) views as a deficit model and is indicative of the idea that literacy problems are easily solved by plugging gaps in knowledge. This view of academic writing as a monolithic form of discourse endured into the 1980's (Chafe, 1986; Chafe & Danielewicz, 1987; as cited in Conrad, 1996).

Within the 80's and 90's researchers began to recognize that academic writing is not a single form of discourse. Halliday and Martin (1993) trace the differences of writing in the disciplines back to 17th century Europe (particularly England and France) where a language of science was developed to codify new scientific knowledge by being able to systematically construct technical taxonomies so that the language would have linguistic methodology (through morphology) in place to categorize new discoveries. As this language continued to develop, the grammar of the language organically evolved in a way that set it apart from non-scientific uses of language. These lexico-grammatical differences are, ac-

cording to Halliday and Martin, easily identifiable even by school children as the language of science. Elbow (1991) also considers the differences in disciplinary language obvious, stating that it is common knowledge that academics in different disciplines do not write in the same way. He further points out that within a discipline there may be multiple (written) discourses, making composition instructors ill-equipped for teaching "academic discourse." Rhetoricians also questioned the value of the *research paper* assignment in freshman composition classes (Macrorie, 1980) arguing that such assignments should be the domain of specific disciplines (Larson, 1982; North, 1982). Some advocated for the importance of helping students find an authentic voice through writing, rather than focusing on assignments intended to mimic disciplinary writing styles (Macrorie, 1980; Spellmeyer, 1996). Sutton (1997), however, feels there are skills that are common to writing in many disciplines that students would benefit from learning in a freshman composition course and advocates for modest exposure to various genres a student might encounter in the disciplines, though he is not clear as to how such exposure translates to writing assignments. Indeed, the interrelatedness of research genres is stressed by Swales (2004) as well as Bhatia (2004) who suggests that genres, though dynamic and shaped by a multitude of overlapping influences, cut across disciplines so that the genre of *textbooks*, for example, will serve similar purposes across many disciplines.

The argument regarding the utility and teaching of service writing courses continues in the area of second language writing, where Belcher (1995)argues for seeking out, and helping students seek out, the more generic features of genres, in this case critical reviews (book reviews and research article critiques) across a variety of disciplines as a means of helping ELLs (English language learners) learn to write critically. Similarly, Ann Johns (2008) contends that disciplinary writing is highly contextualized and consequently difficult, and arguably futile, to teach in preparatory writing courses (see also Freedman, 1993). Better, according to Johns, is to teach students to become researchers and help them develop sensitivity to genre differences and the ability to handle a variety of text types and writing tasks. Johns

suggests Carter's (2007) classification of writing tasks and response types, termed *metagenres*, as a method for constructing a writing curriculum that trains students to address tasks and texts from different genres. Carter elucidates the connection between things students do (ways of doing) in the discipline, as expressed by the link between knowing and writing. Ways of writing in the discipline enact ways of knowing which come from ways of doing.

2.1.1 Studies of linguistic variation in the disciplines

Over the past 20 years many studies have examined how linguistic features vary across disciplines. Lovejoy (1991), for example, looked at cohesive devices across three disciplines: biology, psychology, and history. He found the distribution of these devices varied according to the focus of the discipline. Other researchers have looked at groups of disciplines such as MacDonald's (1994) study of grammatical subjects in the humanities and social sciences and Kuo's (1999) study of personal pronouns in the sciences, to mention only a few. Many different methodologies have been employed for this purpose with some studies taking a more genre-based approach (e.g. Berkenkotter & Huckin, 1993, 1995; Bhatia, 1999, 2004; Hyland, 2000) while, recently, studies taking a quantitative corpus-based approach have gained popularity (e.g. Biber, 2006; Biber, Conrad, Reppen, Byrd, & Helt, 2002; Fuertes-Olivera, 2007). The most frequently studied academic register has been the research article, perhaps most notably explored in Swales' (1990) *Genre Analysis,* where he describes the move structure of research articles, particularly the three moves used in introductions across disciplines to create a research space (known at the CARS model). The research article has been the focus of many recent corpus-based studies of linguistic variation (e.g. Aktas & Cortes, 2008; Biber & Gray, 2010; Chen & Ge, 2007; Cortes, 2004; Gray, 2011; Koutsantoni, 2004, 2006) though researchers have looked at variation in other registers, including textbooks (e.g. Biber, Conrad, & Cortes, 2004; Conrad, 1996; Freddi, 2005; Moore, 2002). To look more closely at a few studies using a corpus-based approach to disciplinary variation, Conrad

(1996), Cortes (2004), and Gray (2011) will be briefly discussed. Conrad (1996) examines variation across professional and student writing in ecology and American history. Specifically, she compares two registers of professional writing in these disciplines, research articles and textbooks, and also examines how student writing develops as students move through their studies in these disciplines. Cortes (2004) explored the use of lexical bundles in history and biology research articles and found that though the bundles were different in each discipline, they served similar functions in the writing. Gray (2011) attempts a comprehensive description of language variation across six disciplines by conducting a multi-dimensional analysis of a corpus of articles from the premier journals in each field.

2.2 Disciplinary writing tasks and expectations

Writing tasks and expectations are intrinsically tied and mutually influential. Instructors' expectations are often encoded in writing assignments and for that reason, research on both assignments and expectations will be discussed in this section. Studies in this area have generally taken one of two approaches: 1) a strong focus on categorizing and analyzing writing tasks as a way of accessing expectations, or 2) a focus on discussing expectations with instructors and having them describe their writing tasks. The studies taking the first, more quantitative approach tend to cover a broad range of disciplines, while those taking the more qualitative and sometimes ethnographic approach tend to focus more deeply on a single case from a small number of fields. As the present study aims to integrate the strengths of each approach to more fully explore writing expectations, relevant studies employing each of these methodologies are discussed.

2.2.1 Research classifying writing tasks

Horowitz (1986a, 1986b) was one of the first, and arguable most important, studies to analyze and categorize university-level writing assignments across a wide range of disciplines. In this study, writing tasks in the form of handouts, syllabi, and essay exam prompts were requested from 29 courses in

17 distinct disciplines at Western Illinois University, resulting in 54 writing assignments from 28 undergraduate courses and 1 graduate class. Horowitz developed a comprehensive taxonomy organizing the assignments into seven categories ranging in demand based on length and cognitive task: *summary or reaction to a reading, annotated bibliography, report on a specified participatory experience* (lab reports, observation reports), *connection of theory and data, case study, synthesis of multiple sources* (library research paper), and *research project*. Horowitz found that the majority of writing tasks assigned across the disciplines fell into the category *synthesis of multiple sources. Report on a specified participatory experience* and *connection of theory and data* were also frequently assigned. (This study and taxonomy are discussed in detail in chapter 3.)

Horowitz's taxonomy has been applied to narrower studies of writing assignments such as Braine's (1989) classification of writing tasks in science and technology , and Zhu's (2004) look at business courses. Hale, Taylor, Bridgeman, Carson, Kroll, and Kantor (1996) expanded Horowitz's taxonomy in their large-scale study for the Educational Testing Service (ETS), adding *short tasks, plans and proposals,* and *documented computer programs. Short tasks* were the most frequently assigned writing type at the undergraduate level, though, due to a dearth of data from upper division courses only lower-division courses were included in the analysis.

Other studies have derived their own categories from their data. For example, Canseco and Byrd (1989) found seven writing types in their analysis of graduate business writing tasks, while Carstens (2008) found nine categories (*genre types)* in her study of humanities and social sciences. In a much broader study of graduate writing tasks, Cooper and Bikowski (2007) collected syllabi from 200 graduate courses in 20 different disciplines. The researchers identified eleven types of writing assignments with differences among disciplines primarily found in the number of writing tasks required. Disciplines in social sciences, humanities and arts were found to require significantly more writing tasks than science, math and engineering studies. In fact, 53% of classes in the science, math and engineering group re-

quired no writing at all, compared with only 12% of the classes in the social sciences, humanities and arts group. A summary of the studies classifying writing tasks can be found in Table 2.1.

Table 2.1 Studies classifying writing tasks

Reference	Summary
Braine, G. (1989)	Classified science writing assignments according to Horowitz's taxonomy. Found that students are primarily writing lab reports, but that the audience is not always the teacher.
Canseco , G., & Byrd, P. (1989)	Classification of graduate business writing tasks based on 55 course syllabi. Found 7 writing types with examinations being the predominant type
Carstens, A. (2008)	Rhetorical and genre analysis of 186 undergraduate writing prompts in the humanities and social sciences. Found 9 genre types with *critical analyses* preferred in humanities and *project reports* preferred in the social sciences. Both disciplines frequently assigned *essays.*
Cooper, A., & Bikowski, D. (2007)	Classification of graduate writing tasks across disciplines into 11 types, distinguishing between social and hard sciences. Found 53% of courses in science and math required no writing.
Hale, G., Taylor, C., Bridgeman, B., Carson, J., Kroll,B., & Kantor, R. (1996)	Developed classification scheme for 162 writing assignments (both graduate and undergraduate). Categories paralleled Horowitz with addition of short tasks, plans and proposals, and computer programs.
Horowitz, D. (1986a)	Study of 284 essay exam prompts classified into 4 categories based on type of response required. Primarily undergraduate data.
Horowitz, D. (1986b)	Created 7 category taxonomy for 54 writing assignments: summary/reaction to reading, annotated bibliography, report (lab report, observation report), connection of theory & data, case study, synthesis (library research paper), and research report. One of the first studies to develop extensive taxonomy.
Jackson, L., Meyer, W., & Parkinson, J. (2006)	Classification of undergraduate science reading and writing tasks based on faculty questionnaires. The study reports a mismatch between reading and writing tasks.
Zhu, W. (2004)	Categorized 200 undergraduate and graduate writing assignments in business courses into 9 categories following Horowitz (1986), Braine (1989), and Hale et al. (1996). Classification was based in part on interviews with faculty and students.

The major goal of studies of writing tasks is to better understand the writing required of students in the university in order to prepare them for the writing they will do in their chosen fields. Another line of research with the same goal in mind—to better prepare students for writing in their discipline—has looked at instructors' expectations of students.

2.2.2 Exploring instructors' expectations

Much of the research on instructors' expectations has demonstrated that expectations are often more complex than instructors are aware and reflect the instructors' own disciplinary beliefs and experiences both as an individual and as a member of a disciplinary discourse community. Several WID (writing in the disciplines) studies have shown that professors may fail to make their expectations of student writing explicit in part because they may not realize the degree to which their expectations are related to the rhetorical practices of their disciplines (Herrington, 1992; Russell & Yanez, 2003; Thaiss & Zawacki, 2006; Wilder, 2012). Based on interviews with faculty in 14 disciplines, Thaiss and Zawacki (2006) found that when asked about their expectations of undergraduate writers, the instructors tended to repeat similar generic standards for academic writing such being clear, logical, well-reasoned, and grammatically correct. Though the instructors used similar terminology to discuss expectations about writing, the researchers found strong differences in the meaning of these terms as instructors elaborated on their assignments. They found that expectations are a complex mix of generic academic standards, disciplinary standards, and idiosyncratic standards that can be difficult for students to navigate. This mix of disciplinary and idiosyncratic expectations is illustrated in Wilder's (2012) study of undergraduate literature professors' ratings of student writing. Instructors were given 142 student papers to rate, without knowing the papers were written under experimental conditions (i.e. not written for an actual literature course). Four instructors were later interviewed to discuss their ratings on twelve of the papers. While the instructors' rating were similar across papers, demonstrating an adherence to common disciplinary expectations, the interviews revealed differences in the instructors' reasoning for giving the rating, indicating individual preferences and beliefs. Two factors that may have contributed to the relative agreement of the professors are that 1) the student papers were the result of explicit instruction in the rhetorical style of the discipline and 2) the papers were not in response to an assignment from any of the participating instructors.

Part of the problem in defining clear expectations may stem from instructors' reluctance to assign writing tasks that they feel mimic professional genres. Schmersahl and Stay (1992)found that many instructors tend to assign writing tasks intended to help students engage with content material and demonstrate understanding, rather than "as a way into the discipline" (143). Instructors in their study felt that undergraduates are often ill-equipped to handle disciplinary writing tasks leading to a perceived host of ills ranging from plagiarism to disenfranchisement with the discourse of their discipline. Instructors sought to spark students' interest by assigning tasks the encouraged students to make a meaningful connection between course content and their lives with assignments that require an application of theory, or a summary-reaction. This line of reasoning assumes that such assignments are not disciplinary assignments, and that instructors are capable of divorcing their expectations from their rhetorical traditions as they evaluate these tasks.

2.2.3 Students' experiences as writers

A third perspective from which the complexity of writing in disciplines has been explored is through the experiences of student writers. McCarthy (1987), for example, addressed the diversity of writing expectations from a student's perspective in her case study of a student, Dave, during his freshman and sophomore years at college. Though Dave's courses were indeed very different from each other, there were commonalities among the writing assignments, something also found in Carson's (2001) study of students in three different disciplines. Though Carson (2001) focused on the differences between the tasks at each level in each discipline, her results showed that analyzing, synthesizing, and organizing information are important skills in each of these disciplines. McCarthy found that Dave focused so heavily on the differences between his courses and the writing tasks assigned in them that he was unable to see commonalities among the tasks. Because of this, Dave was unable to connect the assignments with previous writing he had done.

Preparatory writing courses, such as freshman composition, are typically required for students perhaps with the intention of giving a student experience with writing that will translate, at least in part, to writing assignments he or she will encounter in their content courses. McCarthy's finding that Dave did not connect his disciplinary writing assignments with previous writing, was echoed in Leki and Carson's (1997)study of matriculated ESL students. They found that ESL students' perceptions of their preparatory writing courses and the writing tasks they encountered in the disciplines did not strongly correlate. The students felt their disciplinary courses required writing that heavily involved the course readings while their ESL writing courses focused on more personal topics. In a study of the literacy demands of an introductory history course, Carson, Chase, Gibson and Hargrove (1992) also found that reading and writing tasks were strongly integrated.

Perhaps being able to make connections between assignments in different courses is only a piece of the picture. Disciplinary writing is a complex literacy task that includes extensive reading and comprehension of varied and complicated texts, critical thinking skills, and the ability to follow the rhetorical (and instructor) expectations of the discipline. A longitudinal case study tracking 20 undergraduate students throughout their college study found that students developed as writers over time through the process of becoming acculturated into their chosen fields of study (Carroll, 2002). Leki's (2007) study of four undergraduates for whom English is an additional language, found writing for the disciplines similarly complex, but also highly individual. This study also reveals that in many undergraduate courses, particularly at the lower levels, very little writing is required.

2.3 Reading and writing in the disciplines

Many studies have taken the approach of looking at writing as one piece of literacy, with reading being the other widely studied component. Because the present study seeks to explore the relationship between course readings and student writing, this section will look at studies discussing the connection between reading and writing in the disciplines. Bazerman (1980) argues that writing in the dis-

ciplines requires a familiarity with literature of the discipline, not only for relevant and current content, but also the conventions used in writing. He contends that reading to understand what is being said and how it is being said is a skill students should begin learning in composition courses.

That course readings are influential for student writing will not be argued in this study. As Haas & Flower (1988) and Ackerman(1991) have both demonstrated through think aloud protocols, students use a complex process of new and previous knowledge to understand academic texts and to transfer that understanding to their writing assignments. What is less studied is the influence of course readings as an example of disciplinary writing. Oftentimes, the course readings are the only source of disciplinary writing students are exposed to. In their exploration of the reading and writing tasks for undergraduate science students at a university in South Africa, Jackson, Meyer, and Parkinson (2006) found a mismatch between the types of writing tasks required, which were primarily lab reports, and the assigned readings, which were predominantly from textbooks. Across the 68 courses in 14 science disciplines included in the study, the lab reports students were most frequently required to produce had more in common with published research articles written for the field than the textbooks students were reading. While the authors do not deny that textbooks serve an important function in the curriculum, they suggest additional input of professional writing in the field, since that type of writing follows a similar model and function to the types of writing science students are expected to produce.

Like the study discussed above, the present study will consider the course readings in psychology and chemistry as a source of disciplinary discourse input for students and will also explore the connection between the linguistic features used in the course readings and those used by students in their writing.

2.4 Corpus-based text analysis of register variation

This section will describe the methodology of multi-dimensional analysis which will be used to analyze the linguistic features of course readings and student writing in this study. Multidimensional

analysis (MD) is a method of linguistic analysis based on factor analysis used to discover how sets of linguistic features co-occur in various registers of language use (Conrad & Biber, 2001). Because MD is based on a large set of linguistic features, studies following this approach are able to achieve a comprehensive description of language variation across registers. In MDA, dimensions are formulated based on the statistical co-occurrence of lexical and grammatical features. Biber (1988) established six dimensions of register variation in his large-scale study of spoken and written English based primarily on the texts in the London-Lund corpus. Each dimension functions as a continuum, with linguistic features tending to cluster at opposite ends of the poles. The dimensions are titled descriptively, based on function: *Involved vs. Informational Production, Narrative vs. Non-narrative Discourse, Explicit vs. Situation-dependent reference, Overt Expression of Persuasion/Argumentation, Abstract vs. Non-abstract Style, On-line Informational vs. Edited,* and *Academic Hedging.* The dimensions are listed in decreasing order of significance with Dimension 1 yielding the most data and therefore the clearest interpretation. Dimensions six and seven rely on very few linguistic features and are interpreted tentatively by Biber. This seminal study showed that spoken and written registers (and sub-registers) demonstrate vastly different linguistic behavior establishing an effective methodology for studying linguistic variation that has been followed for over two decades.

Multidimensional analysis has typically been used in linguistic analyses of register variation in two ways. Either the seven (or more typically the first five) dimensions established by Biber (1988) are used to study variation in other registers, or a new MD is conducted with the formulation of new dimensions resulting from the findings of a multi-dimensional factor analysis of linguistic features (Conrad & Biber, 2001). Both approaches provide valuable contributions to the understanding of how language functions in different conditions. Using the established dimensions furthers understanding of how these dimensions function in different registers. Biber and Finegan (2001) looked at how the linguistic features used in medical research journals cluster on each of the first five dimensions compared to some of

the registers studied in Biber (1988). Conrad (1996) plotted the linguistic features of student writing, professional writing, and textbooks in ecology and history on Biber's (1988) dimensions to better understand how these registers vary in their use of linguistic features. Helt (2001)used the dimensions to study variation between spoken British and American English. By applying Biber's (1988) dimensions, which were based on broad sample of English, to narrower registers, these studies have not only contributed to our knowledge of linguistic variation, but have also demonstrated the robust nature of the dimensions themselves.

Many studies have used MD methodology to formulate new dimensions for a particular register. In studies of this type researchers compile a large corpus of texts and use factor analysis to create new dimensions based on the co-occuring features. Individual texts are then plotted on these dimensions. Three important studies that have used this approach are Reppen's (2001) study of register variation in the spoken and written language of school age children and adults, Friginal's (2009) research on call-center English in the Philippines, and Gray's (2011) study of register variation among research articles from six disciplines. These studies are vastly different from each other, but each has used the MD approach to tailor fit the dimensions to the discourse registers they were investigating. In other words, in each of these studies, generating dimensions based on the data the researchers collected gave more insight into the variations of the registers being investigated than would have been possible by using Biber's original dimensions to describe their data.

In the present study, multidimensional analysis will be used to describe the linguistic variation found between student writing and course readings in chemistry and psychology. As both registers fall under the umbrella of academic writing, the MD will follow the dimensions established by Gray (2011). The methodology followed is fully described in chapter 3.

2.5 Conclusion

This chapter has reviewed studies related to each of the research questions the present study investigates. The literature reviewed on academic writing and the diversity of academic writing in the disciplines lays the foundation motivating the exploration of undergraduate writing in psychology and chemistry, the major aim of this study. Studies in this area have shown that not only is academic writing a complex term that needs careful unpacking, but that writing across academic disciplines is one part of academic literacy involving thinking, knowing, reading, writing, and oral discourse in addition to the complex process of becoming acculturated into a discourse community. The present study endeavors to acknowledge disciplinary writing as contextually situated by exploring disciplinary undergraduate writing from multiple perspectives, including interviews with instructors and students and an analysis of course readings in addition to student writing. To do so, the study draws on previous research in the areas of linguistic diversity of academic writing, the analysis of writing tasks, instructors' expectations of student writing, as well as student experiences as writers in the disciplines. Methodologically, this study combines the qualitative interviews found in studies exploring instructors' expectations of, and students' experiences with disciplinary writing (McCarthy, 1987; Schmersahl & Stay, 1992; Thaiss & Zawacki, 2006; Wilder, 2012) with an analysis of writing tasks based on the taxonomy developed by Horowitz (1986) and a more quantitative multidimensional analysis of course readings and student writings based on the work of Biber (1988), Conrad (1996), and Gray (2011).

3 METHODOLOGY

The methodology chapter is divided into two major parts. The first part will explain the methods of data collection for each section of the study including the setting for the study, focal course selection, writing assignment collection, survey creation and distribution, interview methods and participants, and corpus collection. The second part will describe the methods of analysis used for each section.

3.1 Methods of data collection

This section begins by describing the setting in which the data were collected. Contexualizing the study through a description of the setting is crucial as this context unavoidably frames and influences the entire study. Next, I will explain the criteria for selecting the psychology and chemistry courses that are the focus of this study (focal courses). The focal courses included critical thinking through writing (CTW) courses from both psychology and chemistry, as they (CTW courses) are mandated as part of a campus-wide initiative. A high percentage of the final grade in CTW courses is allocated to writing assignments. The CTW initiative and the importance of these courses to the study are further explained later in this chapter. Next, the collection of the writing prompts from the focal courses is explained, followed by the creation and distribution of surveys, and the selection of interview participants. Finally, I describe the methods for collecting the course readings corpus and the student writing corpus for each discipline.

Informed consent was obtained from all participants for the portions of my study requiring human participants, such as the surveys, the interviews, and the collection of student writing samples following the approved procedures of procuring consent under the authority of the Institutional Review Board (IRB) at Georgia State University. Protocol number H10371 was approved by the IRB for this study. The consent forms used in this study can be found in Appendix A.

3.1.1 Setting

All the data for this study were collected at a large research university in the southeastern United States. At the time of data collection, the university had more than 28,000 undergraduates enrolled full-time. The psychology department had approximately 1500 undergraduate majors and was among the largest departments in the university. About forty full time faculty members worked in the department. The chemistry department had 374 majors and about fourteen full-time faculty members. The disparity between the sizes of the two departments affected the availability of and accessibility to data.

3.1.2 Focal courses

In selecting courses for this study I considered each undergraduate program holistically with the goal of choosing courses that represented a path a typical undergraduate student might take as they progress through their major. Courses were chosen based on the recommended course plan for undergraduate majors in psychology and chemistry found on each department's website and included all courses that are requirements for the major (with one exception in chemistry) . I also contacted the director of undergraduate studies in psychology and chemistry to inquire about popular or recommended selections among elective courses. In psychology, the director explained that students have a lot of choice in their course selections and recommended I choose courses that fit the course plan on the department website. The chemistry director advised me to include Spectroscopy (Chem 4190) as it is part of the undergraduate writing sequence and was offered during that semester. To narrow down elective choices, I considered the number of sections various elective courses were allotted, as courses with several sections might represent a more typical choice for a student.

3.1.2.1 Focal courses in psychology

The psychology focal courses described in this section can be seen in Table 3.1 below. In psychology, four courses from the lower division were selected: natural science aspects of psychology (Psyc

1100), introduction to general psychology (Psyc 1101), introduction to applied psychology (Psyc 2040), and introduction to human sexuality (Psyc 2070). At the upper division four courses from each level were selected with the addition of one 4000 level course, a senior seminar and CTW course which will be discussed in greater detail in section 3.2.1.3. The upper division courses selected were: interpersonal behavior (Psyc 3110), abnormal psychology(Psyc 3140), introduction to research design and analysis(Psyc 3510), advanced research design and analysis(Psyc 3530), social psychology (Psyc 4020), cognitive psychology (Psyc 4100), theories of personality(Psyc 4160), environmental psychology(Psyc 4520), and psychology of war (Psyc 4800). These selections are representative of courses a psychology major is required to take along with electives that are frequently chosen. More electives have been included than a typical student would be required to take in order to have a more representative sample.

Table 3.1 Psychology focal courses

Course number	Course name	Required or elective
Psyc 1100	Natural Science Aspects of Psychology	recommended
Psyc 1101	Introduction to General Psychology	required
Psyc 2040	Introduction to Applied Psychology	students must take 2 courses at the 2000 level
Psyc 2070	Introduction to Human Sexuality	students must take 2 courses at the 2000 level
Psyc 3110	Interpersonal Behavior	elective
Psyc 3140	Abnormal Psychology	required, but a choice among 5 courses
Psyc 3510	Introduction to Research Design and Analysis	required
Psyc 3530	Advanced Research Design and Analysis	required, CTW
Psyc 4020	Social Psychology	required, but a choice among 5 courses
Psyc 4100	Cognitive Psychology	required, but a choice among 4 courses
Psyc 4160	Theories of Personality	required, but a choice among 5 courses
Psyc 4520	Environmental Psychology	elective
Psyc 4800	Psychology of War	required, but a choice among several seminars bearing the same course number, CTW

3.1.2.2 Focal courses in chemistry

The undergraduate program in chemistry is based on a balance of theory and practice with many of the courses having a laboratory component. In chemistry, all major writing occurs in the laboratory, making it essential that laboratory courses and course components were included in the focal course selection. At the lower division, the laboratory components of Chem 1151/1152 and Chem 1211/1212 (see Table 3.2) have been included. At the upper division, laboratory courses are often required and listed with a separate course number (e.g. Chem 3100; see Table 3.2). At the lower division six focal courses were selected: survey of chemistry I (Chem 1151), survey of chemistry II(Chem 1152), principles of chemistry I (Chem 1211), principles of chemistry II (Chem 1212), introduction to chemical analysis(Chem 2010) and organic chemistry I(Chem 2400). Because the first four courses are taught sequentially, as the course numbers indicate, I also included two courses from the 2000 level. At the upper division three courses were chosen at each level: organic chemistry lab I (Chem 3100), organic chemistry lab II (Chem 3110), organic chemistry II (Chem 3410), fundamentals of chemical analysis (4000), physical chemistry II (Chem 4120), and instrumental methods III: spectroscopy (Chem 4190).

Table 3.2 Chemistry focal courses

Course number	Course name	required or elective
Chem 1151	Survey of Chemistry I	recommended elective
Chem 1152	Survey of Chemistry II	recommended elective
Chem 1211	Principles of Chemistry I	required
Chem 1212	Principles of Chemistry II	required
Chem 2010	Introduction to Quantitative Analysis	elective
Chem 2400	Organic Chemistry I	elective
Chem 3100	Organic Chemistry Lab I	required
Chem 3110	Organic Chemistry Lab II	required
Chem 3410	Organic Chemistry II	required
Chem 4000	Fundamentals of Chemical Analysis	required, CTW
Chem 4120	Physical Chemistry II	required
Chem 4190	Instrumental Methods III: Spectroscopy	required

3.1.2.3 The CTW initiative

The critical thinking through writing (CTW) initiative at Georgia State University mandates that all undergraduate degree programs across the university have two courses focused on helping students demonstrate critical thinking skills through writing assignments appropriate to the discipline. These courses are required for all majors with the first course serving as a prerequisite for the second. The writing is both taught and assessed through the iterative process of drafting and revision, with the idea that students will receive more feedback from the instructor and have multiple opportunities to improve than in a traditional course. Generally the first course provides more explicit writing instruction and more opportunities for revision, while the second serves to reinforce the skills previously learned. Each department has a designated CTW ambassador who serves as a liaison between the department and the CTW committee, reporting departmental outcomes to the committee and CTW guidelines to the department among other responsibilities. Each CTW class is capped at a maximum enrollment of twenty-five students and must be taught by a full-time member of the faculty. Adjunct lecturers and graduate students cannot teach these courses. The goal of the CTW initiative is to increase the critical thinking skills of all undergraduates across the university as demonstrated through disciplinary writing.

For the purposes of this study, the first CTW course in each discipline has been included. These are Advanced Research Design &Analysis (Psyc 3530) and Fundamentals of Chemical Analysis (Chem 4000). The importance of these courses to the study cannot be overstated as these are the courses in which the goal is to encourage students to “use the tools that they have learned in their courses to think like members of their discipline” and students’ ability to do so is assessed through disciplinary writing ("What is CTW?," 2011).

The second CTW courses in both chemistry and psychology have been partially included in this study. In both programs, the second CTW course is a specialized course for upper-level students. In psychology the seminar offerings vary each semester depending on faculty and student interests. The topics

for the seminars are highly specialized and not those typically offered in psychology undergraduate programs. These seminars allow faculty the rare opportunity to teach a research interest at the undergraduate level and students the opportunity to taste a specialization in psychology not usually available at that level. While these seminars have a strong focus on writing, the course is a content course rather than a skills-based course. In other words, though students will be required to complete extensive writing projects and given opportunities to draft and revise their work based on feedback, the aim of the course is not to teach students how to write, but to teach them the content of the course. Students are expected to apply the knowledge and skills they have developed in Psyc 3530, the first CTW course which focuses primarily on teaching writing and critical thinking skills appropriate to psychology (Collins; Rowe, personal communication).

The seminars offered under the course number Psyc 4800 during the time of this study were Psychology of Consciousness; Play, Learning, and Cognitive Development; Psychology of War, and Forensic Psychology. I have included the course syllabus and student writing samples from the seminar Psychology of War as an extra course at the 4000 level. I have not, however, included the course readings for Psychology of War. The readings for this seminar were included in a course pack assembled by the professor and included various types of readings. The readings across seminars bearing the same course number were too dissimilar to be considered representative of the type of reading students would experience across sections of this course.

In chemistry, the second CTW course (Chem 4160) is an independent research course that serves as the capstone course of the program. Students choose to sign up to work in a research laboratory of a particular faculty member under the direct guidance of a postdoctoral scholar or graduate student mentor. The student actively participates in a small part of the research being conducted in the lab and is responsible for producing a written report of their work at the end of the semester. Students receive guidance and feedback on their written work first from their mentor and ultimately from the

funded professor. Because of the individualized nature of this course, it was impossible to include it in this study, though the course is discussed in the student interviews.

3.1.3 Writing prompts

In order examine the types of writing students are asked to do in their undergraduate majors in psychology and chemistry, it was necessary to collect the assignments given to students for various writing tasks. To begin, syllabi were collected for each of the focal courses. Once the course syllabi were collected, I contacted the instructors of courses that listed writing assignments in the syllabus to request additional handouts, instructions, or scoring rubrics pertaining to the assignments. In psychology, instructors provided these materials when available. In chemistry, most instructors said they did not give handouts related to writing assignments and pointed me to the laboratory manuals for more information. In the interviews with both chemistry students and professors, however, several interviewees mentioned providing or receiving printed guidelines for writing up final reports. The laboratory manuals do give specific instructions for formatting and writing laboratory reports. Examples of writing assignments in psychology and chemistry can be found in Appendix D.

3.1.3.1 Classification taxonomy

The writing prompts from the focal courses in chemistry and psychology were categorized following the classification scheme developed by Horowitz (1986). Horowitz identified seven categories of writing assignments, namely: *summary of / reaction to a reading, annotated bibliography, report on a specified participatory experience*, *connection of theory and data, case study, synthesis of multiple sources*, and *research project*. Horowitz provides a detailed description of each category including an explanation of possible overlap between categories and the circumstances that made him choose one category over another. A summary of his category descriptions is provided in Table 3.3 along with the assignment types Horowitz placed in each category. In Horowitz's words, "To be useful, a scheme must

have enough specificity to capture essential differences among tasks and enough generality to place into the same category essentially similar tasks which might appear to be quite different" (449). Horowitz's classification scheme is applicable to other studies, such as the present study, because he strikes a balance between specificity and breadth with his clear explanation of each category.

Table 3.3 Description of categories in Horowitz's (1986) taxonomy

Category	Description	Assignment types
Summary of/reaction to a reading	typically, a summary of a journal article suggested by the instructor, followed by a reaction. Usually, organizational scheme provided by instructor	summary, reaction paper, summary-response
Annotated bibliography	Format and number of entries explicitly provided by instructor	
Report on a specified participatory experience	Data needed not obtained through writing; students observe or participate in a "scene;" writing task involves reporting details of the experience and drawing a conclusion regarding its meaning	laboratory reports, observation reports
Connection of theory and data	theories come from class lectures and outside reading, connection is based on other reading, personal experience, or other experience; similar to previous category	
Case study	students use class learning/reading to solve a problem; data typically provided by the instructor	case study
Synthesis of multiple sources	topics are usually provided by instructor; most typically informative	library research paper
Research project	proposal or completion of a survey or experiment of student's design; organization typically given by instructor	research proposal, research project

I did not feel constrained by Horowitz's classification scheme and was willing to create new categories for prompts that did not clearly fit his taxonomy. This was not necessary, however. The writing

prompts in both chemistry and psychology easily aligned with his categories. *Annotated bibliography* was the only category not found in my analysis. Using Horowitz's taxonomy allowed me to compare my results more easily with previous studies following his methodology.

3.1.4 Surveys

Two surveys were created as a preliminary measure to understand the perceptions of the value of reading and writing in undergraduate courses in chemistry and psychology. One survey was distributed to faculty in each department and the other to students. Parallel questions were asked on both surveys, but designed to reflect the different perspective of students and faculty. Because faculty may be teaching multiple undergraduate courses and students are usually enrolled in several courses in their major, respondents were asked to consider one course for the purposes of the survey. Both surveys were created using the *forms* feature in Google Docs. This allowed the survey to be accessed online at the respondent's convenience, with the responses immediately available to the researcher in spreadsheet format.

3.1.4.1 Faculty surveys

The faculty survey consisted of six preliminary questions, including the courses frequently taught and class size, and thirteen questions about the importance and purpose of reading and writing to the course. The full survey is included in Appendix C. The survey was distributed to undergraduate faculty via a link in an e-mail. I also spoke with the undergraduate director in each department to ask for their assistance with encouraging faculty to respond. The undergraduate director in psychology announced the survey at a faculty meeting, and the undergraduate director in chemistry sent a follow-up e-mail. Hard copy requests with the web address for the survey were additionally distributed to chemistry faculty.

3.1.4.2 Student surveys

The survey for students included eight preliminary questions including one asking for contact information for students willing to participate in a follow-up interview and thirteen questions regarding the importance and purpose of course readings and writing assignments. The full survey is included in Appendix C. To distribute the student surveys, I first contacted the administration specialist in each department to ask if they could forward an e-mail request with a link to the online survey to all undergraduate students enrolled in the department. In both departments my request was denied due to apparent student privacy violation concerns. I then contacted the instructors of several undergraduate courses and asked if they would be willing to forward my request and survey link to students in their courses (with limited success in chemistry). As a third measure, I included a survey request with the web address with the writing consent forms I hand distributed to students in writing intensive classes. I verbally explained the survey to the students and asked for their assistance recruiting other respondents.

3.1.5 Interview participants

In order to better understand the issues involved in undergraduate student writing, I wanted to hear the voices of those in charge of establishing departmental policies toward writing and undergraduate studies, those instructing undergraduate students, and the students themselves. Interview participants are discussed in the present tense, though their circumstances have undoubtedly changed since the time of the interview. The interviews followed the exploratory interview style used by Leki and Carson (1997). An interview guide was used, however, the questions were open-ended and intended to direct the conversational style of the interviews. Many times, the interviewee would discuss something that lead to questions worth exploring, but not anticipated on the interview schedule. Interview guide examples for faculty and students are included in Appendix B.

The interviews were conducted in a space of the participants choosing. The faculty interviews all took place in their offices. The student interviews took place in various locations that were convenient

to the students. Some were conducted in empty chemistry laboratory classrooms, some in unoccupied offices in the applied linguistics department, and one interview took place in a coffee shop on campus. I verbally explained the study to all interview participants and provided them with an IRB approved informed consent form. All participants were given the opportunity to discontinue participation in the study at any time.

3.1.5.1 Faculty

I chose to interview faculty from the departments of chemistry and psychology who were closely involved in teaching undergraduate courses and in making policy decisions regarding enrollment and course requirements. I began by contacting the department chairs and requesting an interview. I planned to interview four members of each department; the department chair, the director of undergraduate studies, and a junior and senior professor. The department chair in psychology suggested faculty members he felt might be valuable to my study. I contacted them and both were willing to participate. The chair of chemistry declined to be interviewed as he felt he would not be able to make valuable contributions on the subject of undergraduate writing. He assisted me in contacting the director of undergraduate studies, whose insights were invaluable to my understanding of the undergraduate program and the part writing plays. I contacted several additional instructors in chemistry based on the number of undergraduate courses they typically teach. Two additional professors agreed to participate in the interviews. In total, I conducted seven interviews; four with psychology faculty and three with chemistry. Each faculty member was interviewed once with follow-up questions asked via e-mail. The interviews lasted an average of an hour, with the longest interview lasting 97 minutes and the shortest 35 minutes.

Tables 3.4 and 3.5 give a brief profile of each of the professors interviewed in psychology (3.4) and chemistry (3.5). The tables give a pseudonym for each professor along with their position in the department, the courses they usually teach, and any additional, relevant information.

Table 3.4 Profile of interviewed psychology faculty

Pseudo-nym	Position	Courses typically taught	Additional information
Dr. Pen-fold	Chair	Cognitive Psychology (4100), Psychology of Learning	
Dr. Rowe	Undergraduate director	Intro to Research Design and Analysis (3510), Devel-opmental Psychology (4040), Adolescent Psychol-ogy (4300)	
Dr. Spen-cer	Assistant pro-fessor	Advanced Research Design & Analysis (3530)	PhD in psycholinguistics developed 3530, now course coordinator, CTW ambassador
Dr. Collins	Lecturer	Advanced Research Design & Analysis (3530), Psycholo-gy of War (4800)	Established psychology writing center staffed by undergradu-ate volunteers with strong writ-ing skills

Table 3.5 Profile of interviewed chemistry faculty

Pseudonym	Position	Courses typically taught	Additional information
Dr. Arnett	Undergraduate director	Fundamentals of Chemical Analysis (4000)	Writing course coordina-tor/ambassador
Dr. Dayton	Professor	Organic Chemistry I (2400), Practical Organic Chemistry (3410), Organic Chemistry II (3100)	Mentor for pre-med students
Dr. Easton	Assistant pro-fessor	General Chemistry (1211 &1212), Organic Chemistry II (3100), Organic Chemistry II Lab (3110)	

3.1.5.2 Students

Student participants were recruited for this study in several ways. A question on the survey and on the writing sample consent forms asked if the respondent would be willing to participate in a follow-up interview. In addition, I asked faculty during their interviews if they could recommend any students

who might be good candidates to interview. I aimed to interview an equal number of men and women who were advanced enough in their degree program to have completed significant writing assignments but still involved enough to be able to comment and reflect on writing without having to recall situations and events too far in the past.

I began by contacting the students who indicated they would be willing to be interviewed on their survey or writing consent form. In psychology, this yielded the most affirmative responses. I ended up with six interviewees, two of whom were also recommended by faculty. One male student did not show up for the interview, leaving two male and three female interviewees in total. No chemistry students indicated that they would be willing to be interviewed on the survey and the faculty I interviewed would not recommend students to me. Three students indicated they were willing to be contacted for an interview on the writing consent forms, but when contacted, only one was actually available. I contacted undergraduates who had been identified as chemistry award winners on the department website. All the students I contacted were willing to be interviewed. In total I interviewed two females and four males. I chose not to include one interview in the study because the participant did not answer my questions, but spoke at length about his personal philosophy regarding life and the connection between science and the progression of thought in the twentieth century. His interview was an outlier, in that it did not relate to any of the topics addressed by the other interviewees.

Each student was interviewed one time, with each interview lasting approximately thirty minutes. The longest interview was just over forty-five minutes and the shortest was just over twenty minutes. In the following section I give a brief profile for each student interviewed using a pseudonym.

3.1.5.2.1 Psychology students

This section gives a brief profile for each of the psychology students. Pseudonyms have been used. Following the profiles, table 3.6 gives a picture of the students' age and year in their program.

Amelia is a twenty year old female in her junior year. She chose psychology as a major initially because she wanted to become a therapist. After taking more psychology courses, she became more attracted to the scientific aspects of research. She is enrolled in the newly added honors section of Psyc 3530. Amelia has been awarded a research assistantship and is working in a psychology lab for a senior faculty member.

Marco is a nineteen year old male also in his junior year. He is a bilingual speaker of English and Spanish and considers Spanish his native language. He knew before beginning college that he wanted to major in psychology. He took a general psychology class and advanced placement psychology in high school and was, in his words “captivated.”

Edward, a twenty year old male in the second semester of his junior year, decided to major in psychology after considering several other majors such as marketing economics and journalism. He self-describes as an analytical person who likes concrete concepts and math, but also had a desire to help people. After taking courses in different departments, he felt like psychology was the best fit for him.

Lindsay is a twenty year old student in her senior year. She is applying to graduate programs in psychology, which she hopes to start immediately after graduation. She is a tutor in the newly established psychology writing center where she helps undergraduates primarily in Psyc 3530 with writing for psychology.

Anna, a senior in the psychology program, is forty-two. She started her college career as an English literature major, but felt it was not a practical choice for her. She turned to psychology with the plan of becoming a therapist eventually. She is planning on attending graduate school after she graduates and is hoping to continue at this university. She, like Amelia, has a research assistantship in a psychology lab where she is working on a study of maternal depression and its effects on college students.

Table 3.6 Students in psychology

Pseudonym	Sex	Year	Age
Marco	M	3	19
Edward	M	3	20
Lindsay	F	4	20
Amelia	F	3	20
Anna	F	4	42

3.1.5.2.2 Chemistry students

This section gives some background information on the chemistry students who were interviewed. Two of the students are not undergraduate students, but their backgrounds made them good candidates for interviews. I discuss these reasons further in the profiles of Richard and Janet below. As with psychology, table 3.7, which follows the profiles gives a picture of the ages and academic years of the students.

John is in his senior year in chemistry. He is twenty-two years old and has already been accepted to the master's program in chemistry at Georgia State. His interest in chemistry was inspired by his father's enthusiasm for the subject. In high school he took advanced placement chemistry and his father would help him study. He enjoyed that course and the instructor and knew at that point that he wanted a career in chemistry.

Richard is a twenty four year old master's degree student. He transferred to Georgia State as an undergraduate from a university in north Florida. He recently completed his undergraduate degree in chemistry and is in his first semester of the master's program. He is now applying to doctoral programs in chemistry. Richard's position as a recent graduate as well as someone pursuing advanced study in chemistry at the same university, gives him an interesting perspective on the program and its writing

goals. Richard also has an interest in literature and creative writing. He discussed his awareness of genre differences and how he used this understanding to help him become an effective writer in chemistry.

Janet, twenty-eight, is a post baccalaureate student. She has a bachelor's degree in psychology from Georgia State and a master's degree in professional counseling from Mercer University. After working in the field as a case manager for two years, she decided to return to school to become a physician's assistant. She is taking required chemistry courses in order to apply to a PA program. Though Janet is not an undergraduate, nor chemistry major, I chose to interview her because of her extensive experience in psychology and current enrollment in chemistry.

Kathleen is a twenty-two year old senior in chemistry. She became interested in chemistry in high school and is currently involved in laboratory research related to pharmacology and drug development. She hopes to continue this line of work in her graduate studies. She will attend the fifth year Master of Science program at Georgia State after graduation.

Daniel is twenty-three years old and a senior chemistry major. Before settling on chemistry as a major, Daniel tried several other majors in the sciences. He was a pre-medical student, but ultimately decided he did not want to go to medical school. He felt pressure to decide on a major and knew that he liked laboratory work, so he chose to major in chemistry. He plans on attending graduate school after finishing his bachelor's degree and is considering becoming a high school teacher. He is presently certified to teach physics and working on his math certification.

Table 3.7 Students in chemistry

Pseudonym	Sex	Year	Age
Janet	F	Post Bac	28
Kathleen	F	4	22
John	M	4	22
Daniel	M	4	23
Richard	M	Master's	24

3.1.6 Corpus collection

Two corpora were collected for this study, the first containing the course readings from the focal courses in psychology and chemistry and the second comprising samples of student writing at the upper division in each discipline. The composition of each corpus is described in detail in section 3.2.4 in this chapter.

3.1.6.1 The readings corpus

The required texts listed in the syllabi for each focal course were collected and ten percent of the texts were scanned in order to comply with copyright regulations. In most cases, the required texts were textbooks, though in psychology, one journal article and one general audience book were required. In chemistry, laboratory manuals were also collected. The laboratory manuals were scanned in their entirety, as I had permission from the creators and distributors of the manuals to use the full text. After scanning, the texts were converted to plain text files and "cleaned." Cleaning involves manually checking each text and removing or changing any characters that may have been altered during the conversion. The reading subcorpus in psychology included fifteen texts and totaled 377,970words. The chemistry subcorpus included fourteen texts and totaled 300,048 words.

3.1.6.2 The student writing corpus

Samples of student writing were collected from upper division courses in both chemistry and psychology. In order to request submissions, I obtained internal review board approval and had each student sign an informed consent form giving their permission to use their writing in my study. All writing was used anonymously. I distributed consent forms during the first five minutes of class with the permission of the instructor. After distributing the forms, I left the room. The instructors would put all the forms in an envelope and hand it to me. In one chemistry class, the instructor asked if I could pick up the consent forms at another time, as students were starting a test. When I returned to retrieve the consent forms, they were missing.

There were two additional challenges in obtaining writing samples. The first was in obtaining consent from the students. In both chemistry and psychology, many students chose not to sign the consent forms. The second was in getting the students to submit their writing. I distributed consent forms well before the deadlines for major writing assignments and asked students to send their writing to me when they had finished them. I kept a list of consenting students and e-mailed them every week until they had given me their papers. In total the psychology subcorpus comprises 57 texts and 90,076 words and the chemistry subcorpus contains 34 texts and 52,424 words.

3.2 Methods of Analysis

This section of the chapter explains the methods used to analyze the data collected for each part of the study. I begin by describing the taxonomy followed to classify the writing assignments from the psychology and chemistry focal courses. Next, I explain the intended methods for analyzing the survey data and why they were not followed. Then, the method followed for analyzing the interview data is described, followed by an explanation of multidimensional analysis, the method of analysis chosen for the corpus data.

3.2.1 Writing assignments

Each of the writing prompts were carefully read and the language of the prompt was matched with the descriptions of the seven categories in the Horowitz (1986) taxonomy (see Table 3.3 above for a summary of the category descriptions). In most cases, the language used in the assignment prompts clearly matched the description of a particular category. Occasionally, a prompt, such as the diagnostic impression report in abnormal psychology, would seem to fit more than one category, in this case the category *connection of theory and data* and the category *case study.* Horowitz's definition of *case study* included two criteria that fit this prompt; 1) that class learning or theory is used to solve a problem rather than explain how theory fit the data, and 2) all the necessary data were provided by the instructor. Both of these conditions existed in the prompt, making it a fit for this category. Horowitz admits that the lines between the categories are not always clear, but usually there are some distinguishing criteria that separate the tasks. The classification of the writing assignments analyzed in psychology and chemistry for the present study is presented and described in Chapter 4.1.

3.2.2 Surveys

The results of the survey data were intended to be analyzed statistically, following the methods for survey analysis outlines in Fink (1995). Because the populations are small, in order to reach 95% confidence in most cases the sample size is close to the entire population. There were too few survey respondents to be able to determine central tendency or to be able to generalize from the sample to the population (Babbie, 1990). The numbers of responses in each category (students and faculty in each discipline) are given in chapter 4.3.

3.2.3 Interviews

All of the interview participants gave permission for the interview to be digitally recorded with a Sony IC Recorder. The interviews were transcribed and the transcriptions were coded for themes using

Atlas.ti 6.2 qualitative analysis software (GmbH, 2009). The interviews were read iteratively until themes emerged, following the techniques in Ryan& Bernard (2003). Smaller themes were collapsed into larger themes resulting in four clear themes in both the psychology and chemistry faculty interviews, and three themes each in the student interviews. These themes are discussed in chapter 5. The interview protocols can be found in Appendix B.

3.2.4 Corpus Analysis

As described in chapter 2, multidimensional analysis (MD), a method of text analysis developed by Biber (1988), uses factor analysis of a wide variety of linguistic features to determine how those features tend to cluster together. Dimensions are formulated by examining the function of groups of co-occuring features. Dimension scores for individual texts or registers can be obtained to better understand the functional operation of linguistic features within the texts or register. As MD is perhaps the most comprehensive method for analysis of the occurrence and co-occurrence of a large number of linguistic features across a body of texts, this method was chosen for analyzing the course readings and student writing corpora compiled for this study.

Multidimensional analysis can be carried out in two ways (Conrad & Biber, 2001). A collection of texts tagged for the linguistic features can be plotted on dimensions already created by previous researchers thereby increasing understanding of the range of registers or text types that fit each dimension. Typically, these types of studies have followed Biber's 1988 dimensions (e.g. Biber, Csomay, Jones, & Keck, 2004; Biber & Finegan, 2001; Conrad, 1996). Any study in which dimensions have been created can, however, be used. The second way to conduct a multidimensional study is to generate new dimensions based on the registers under investigation. In order to do so, a corpus must include five times as many observations, in this case texts, than variables, that is linguistic features that will be used in the analysis (Biber, 1988). Since multidimensional analysis typically looks at about 70 linguistic features, depending on the particular study, a corpus must include about 350 texts. As the present study includes

119 texts, conducting a new multidimensional analysis was inadvisable. Biber's 1988 dimensions were created based on a broad scope of language covering many registers, and would not be entirely appropriate for a study of strictly academic texts, as is the focus of this study. Gray (2011) conducted a new multidimensional analysis based on a study of academic journal articles from nine disciplinary areas: theoretical philosophy, qualitative political science, quantitative political science, qualitative applied linguistics, quantitative applied linguistics, theoretical physics, quantitative physics, quantitative biology, and qualitative history. The four dimensions generated through her analysis are more reflective of the nature of academic writing, making them a better fit for a study of academic textbooks and student writing.

In the following sections, I will begin by describing Gray's four dimensions and the linguistic features involved in the positive and negative poles of the dimension. I will then describe the process of finding dimensions scores for my data using these dimensions.

3.2.4.1 Description of the dimensions

In a multidimensional analysis, each dimension is given a descriptive title based on the function of the linguistic features that comprise the dimension. Dimensions are named to show the polarity between the clusters of features. For example, Biber (1988) labeled Dimension 1 as involved vs. informational production, showing that texts with a positive score for this dimension demonstrate a higher use of the linguistic features that tend to make a text more involved. Texts with a negative score for this dimension demonstrate a higher use of the linguistic features that tend to make a text more informational. The linguistic features that make a text involved tend to cluster together and are not likely to co-occur frequently with the features that make a text informational. After dimensions are formulated, dimension scores are calculated for individual texts, or groups of texts and they can then be plotted along the dimension to demonstrate the differences in the linguistic features of texts within a register or across registers.

In Gray (2011) Dimension 1 is titled academic involvement and elaboration versus informational density and comprises twenty-six features on the positive end of the factor and eight features on the negative end. The linguistic features on the positive end include various types of pronouns, modifiers, conjunctions marking logical and grammatical relationships, and grammatical structures showing personal stance. The features on the negative end of the dimension are nouns, process nouns, past tense, passives (including passive post nominal modifiers and agentless passive verbs), prepositions, type-token ratio, and word length. All but two of these features have been previously associated with informational purposes particularly in written texts (Biber, 1988, 2006). Dimension 1 highlights the differences in the purposes for academic writing in different disciplines.

In Gray's findings, Dimension 2 , contexualized narration vs. procedural discourse, seems to indicate the differences in the typical ways that disciplines present findings. In her study, the qualitative registers had the highest positive scores for this dimension, while the physical sciences had the most negative scores. There are twenty-two linguistic features in the positive end of the dimension: 3rd person pronouns, group nouns, animate nouns, adjectives indicating topic and time, past tense, perfect and progressive aspect verbs, that-relative clauses, phrasal and clausal coordinating conjunctions and communication verbs. The six features on the negative end include technical, quantity, and concrete nouns, agentless passive verbs and passive verbs with a *by*-phrase, and attributive adjectives indicating size.

As the label suggests, Dimension 3, human versus non-human focus, distinguishes between those linguistic features which indicate a focus on human beings. This dimension consists of eleven features on the positive end and four negative features. The positive pole is characterized by 2nd and 3rd person pronouns, process nouns, mental, activity, and communication verbs, present progressive verbs, *that*-clauses controlled by factive verbs, wh-clauses, *to*-clauses controlled by speech verbs and verbs of desire. The four negative features are attributive adjectives, attributive adjectives indicating topic, general adverbs, and prepositions. As might be expected, Gray's study showed that disciplines concerned

with human as the focus of study tended to have high positive dimension scores on this scale. In her study, applied linguistics, both qualitative and quantitative, and theoretical philosophy yielded the highest positive scores. As both disciplines focus on the human as the subject of inquiry, this is easy to understand.

Gray posits that Dimension 4, 'academese,' may distinguish between registers and disciplines that are explicitly concerned with being labeled as empirical (at the positive end) and those that are not, regardless of whether or not they are actually empirical. Her results show political science and applied linguistics, the two social sciences included in the study, as the only disciplines having positive scores for this dimension, a possible indicator of explicitly marking the scientific nature of inquiry in these disciplines. The dimension has only eight positive features; nominalizations, process nouns, and other abstract nouns, relational attributive adjectives, *that*-clauses controlled by likelihood adjectives, and *to*-clauses controlled by stance adjectives. The sole negative feature for Dimension 4 is time adverbials.

3.2.4.2 Obtaining dimension scores

The first step in obtaining dimension scores is to tag the texts in the corpora for grammatical and lexical information. The texts in this study were tagged using an automatic tagger developed by Biber that assigns each word a code indicating grammatical category (see Biber, 1988). The codes identify about 130 linguistic features relevant to the multidimensional analysis used in this study. The tags are added after each word and each word is then aligned vertically so that the tags can be counted by the program. Table 3.8 shows a brief excerpt from the Psyc 2070 text in both its original and tagged form.

Table 3.8: Example of tagged text: Psyc 2070

Untagged Text	Tagged Text
When a baby is born, new parents are eager to hear whether "It's a Girl" or "It's a Boy," but what if it were neither?	When ^wrb+who+++=When a ^at++++=a baby ^nn++++=baby is ^vbz+bez+aux++=is born ^vpsv++agls+xvbnx+=born, , ^zz++++=EXTRAWORD new ^jj+atrb+++=new parents ^nns++++=parents are ^vb+ber+vrb++=are eager ^jj+pred+++=eager to ^to+jcmp+++=to hear ^vbi+vprv+++=hear whether ^cs+who+++=whether " ^zz++++="It's it ^pp3+it+++=EXTRAWORD 's ^vbz+bez+vrb++0=EXTRAWORD a ^at++++=a Girl ^nn++++=Girl" " ^zz++++=EXTRAWORD or ^cc++++=or " ^zz++++="It's it ^pp3+it+++=EXTRAWORD 's ^vbz+bez+vrb++0=EXTRAWORD a ^at++++=a Boy ^nn++++=Boy," , ^zz++++=EXTRAWORD " ^zz++++=EXTRAWORD but ^cc+cls+++=but what ^wdt+who+++=what if ^cs+cnd+++=if it ^pp3+it+++=it were ^vbd+bed+vrb++=were neither ^dt++neg++=neither? ? ^zz++++=EXTRAWORD

In order to obtain dimension scores for the texts in my dataset, the tags assigned to each lexico-grammatical feature were counted and normed per 1,000 words. The norming process helps to standardize the number of occurrences so that they can be compared across differently sized corpora. Z-scores were then calculated for each of the linguistic features in each of the four dimensions to standardize the scores. A mean score for each register and discipline (e.g. chemistry student writing, psychol-

ogy student writing, chemistry textbooks, and psychology textbooks) was obtained. A one-way analysis of variance (ANOVA) was performed for each dimension to show determine whether there were significant differences between the groups. Because ANOVA assumes a homogeneity of variance, Lavene'stest was performed to determine whether the groups were homogenous enough to substantiate the value obtained from the one-way ANOVA. In the case that Levene's statistic was significant, a Kruskal-Wallis ANOVA, a non-parametric test, was performed. All statistical tests were performed using the SPSS statistical program (IBM, 2011). The mean scores for each register were then plotted for each of the four dimensions. The results of the multidimensional analysis executed for the present study are explored in Chapter 6.

4 WRITING TASKS IN PSYCHOLOGY AND CHEMISTRY

The writing required of undergraduate students in chemistry and psychology increases in amount, type, and relative complexity as students progress through their degree program. This trend, however, is not as intuitive as it may appear. This section will first look at the writing required in the focal psychology courses and then consider the writing in chemistry.

4.1 Writing tasks in psychology

The writing assignments for psychology have been divided between focal courses in the lower upper division. Appendix E contains tables describing the writing required in each of the focal courses in psychology. Each table includes a description of the type of writing in the course, language from the writing prompts, and the task category (Horowitz, 1986). The column labeled "W" gives the relative weight of the writing as a number between 0 and 4. At the lowest end of the scale, writing does not contribute to the overall course grade. A weight of four would indicate that 75% or more of course grade is determined through scores on writing assignments.

Seventy-five percent of the lower division courses in this study do not include writing assignments as a form of assessment. At this level, students are primarily assessed through multiple choice exams. The only course including writing assignments as a method of formal assessment, Introduction to Applied Psychology (2040), requires four summary-response assignments making up thirty percent of the final course grade. The Introduction to Human Sexuality (Psyc 2070) syllabus suggests students take lecture and reading notes and lists essays and short answers as exam question types, but longer writing projects are not required. The finding that very little writing is required at the lower division is not new and has been well documented in the literature (Conrad, 1996; Cortes, 2004; Hale et al., 1996).

At the upper division, two courses (psychology 3510 and psychology 4160) did not include writing assignments as part of the course grade. Psychology 3510 is the first course required in a sequence

of two research design and methodology courses and focuses on statistical analysis and designing rigorous studies. The second in the series, psychology 3530 focuses on writing a research proposal. This may explain why writing is not required in the first course of the sequence. The second course, psychology 4160, Theories of Personality assesses students using four multiple choice and short answer tests. There is no readily apparent reason for excluding writing from the course assessments. In total, forty percent of the psychology courses surveyed for this study solely assess students through examinations. An additional 25% of courses use testing as the primary form of assessment with small writing assignments making up less than 25% of the course grade. This means that only 35% of the undergraduate focal courses in this study assess writing as a substantial percentage of the course grade.

In total, the eight courses with writing requirements yielded 16 assignments with one additional optional assignment. The most frequently assigned category is a *summary of /reaction to a reading*, in which a student must summarize a reading related to the course content and give either a personal reaction or a critique of the article. Nine of the seventeen writing assignments fall into this category across five courses. In most cases finding an appropriate article is the student's responsibility, although the instructor usually provides guidelines. These assignments tend to be the shorter (between 200 words and 1 page) and less cognitively demanding than other more complex papers. Several courses require more than one summary/reaction.

The next most frequently assigned category is *connection of theory with data* with four assignments given in four different courses. The tasks in each assignment vary from watching a film and connecting the themes in the film with concepts discussed in the course to synthesizing two different theories and commenting on the synthesis within the framework of the course readings. Two courses assigned *research projects* with one being a traditional research proposal and the other a rather vague "scholarly paper" written about the student's original design of a public space. Only one course required a synthesis of multiple sources (in the form of a literature review) and only one case study was assigned.

The assignment categorized as a *case study* requires students to write a diagnostic impression report based on a case provided by the instructor. The data for the paper was primarily taken from the description of the case provided for the students making this fit Horowitz's definition of a case study assignment. However, as Horowitz (1986) notes, the dividing lines between a *case study*, a *connection of theory and data,* and a *summary/reaction* are not "hard and fast." There is certainly overlap in these types of tasks and the critical thinking skills each requires.

The results of my analysis are analogous to those found by Horowitz. In his study both summary/reaction papers and connection of theory and data were most frequently assigned in psychology courses. Horowitz did have two psychology assignments in the category *report on a specified participatory experience*, while no such assignments were found in my data set. In my interviews with psychology students, two interviewees mentioned assignments in which they were required to write up interviews they had conducted and comment on them. Such assignments would fall into this category, but the focal courses in this analysis did not include assignments of this type.

Looking at the percentage of the course grade allocated to writing assignments can illustrate the weight and relative importance of writing in the course. The CTW courses had the highest percentage of the course grade allocated to writing tasks; between 50-74%, a weight of three. The remaining courses varied with regard to the percentage of the course grade given to writing tasks. Writing accounted for less than 25% of the course grade in eight courses and in the remaining two writing accounted for between 25% and 49% of the final grade. There are practical reasons for the number of courses requiring no writing and the number of courses with relatively few (and short) writing assignments in psychology. Psychology is among the largest departments at the university with approximately 1500 undergraduate majors at the time of this study. Classes at the 3000 level and below are capped at 72 students or more (usually more for the 1000 level lecture courses). The 4000 level classes are capped at 48 students. Many instructors are teaching their classes without assistants. The grading load is far too heavy to have

students writing significant amounts in these courses. The CTW courses are capped at 25 students, making longer, more complex assignments, and a larger number of assignments per semester more feasible.

4.2 Writing tasks in chemistry

Tables describing the writing required in each of the chemistry focal courses can be found in Appendix E. The tables are divided between lower and upper division course and include a description of the prompt and a number that gives the weight of the writing in terms of final grade for each course.

The writing in chemistry takes place primarily in the laboratory as lab reports or pre-lab reports and accordingly, nearly all the writing assignments are in the category *report on a specified participatory experience*. At the lower division students are not required to write up full reports on their laboratory work. Prior to the work in the lab students write a summary of the procedures to be followed, including the purpose of the experiment, equipment to be used, and a discussion of how the student might interpret their data. These modified laboratory reports follow a structure similar to the more advanced reports students write at the upper division, but fit in the category *summary of/reaction to a reading* because students are largely summarizing and discussing their reading of the experiment procedures. This type of assignment is only found in chemistry 1151 and 1152 where eleven summaries are required in each course. These brief summaries are required prior to every laboratory experiment.

In higher level courses, fewer assignments are required because the experiments are conducted over longer periods of time with one experiment lasting the entire semester in some cases. The fifteen upper division assignments all fit the category of *report on a specified participatory experience.* The number of reports required varies by course with some only requiring a final lab report, some requiring a midterm report and a final report, and in the case of fundamentals of chemical analysis, a CTW course, six reports are required.

Chemistry 4000 is the first in a sequence of writing focused courses in chemistry that pre-date the CTW initiative. The fundamentals of chemical analysis (chem. 4000) is followed by chromatography (Chem 4010) and spectroscopy (Chem 4190). In these courses, writing plays a more central role as students have the opportunity to redraft their assignments to improve their grades. The written assignments carry more weight toward the overall score. In chemistry 4000 students receive explicit instruction on how to successfully write up their laboratory experiments and receive extensive feedback on their drafts from different instructors throughout the semester. The intended purpose of this course is to explicitly teach chemistry majors how to write for the discipline. Though students do similar types of writing at earlier levels in chemistry, this is the first course specifically for chemistry majors in which writing is taught. Some courses, such as organic chemistry, require substantial writing but are frequently taken by non-chemistry majors as a prerequisite.

4.3 Analysis of writing tasks

The writing required in each major reflects the disciplinary differences in the purposes writing serves. In psychology, writing at the undergraduate level can serve several purposes. It is a way for students to display their understanding of course content for their instructor by demonstrating a critical understanding of the content through its application to other areas. The importance of successfully connecting theory and experience in writing is illustrated by the fact that fourteen out of seventeen writing assignments in the psychology focal courses require this type of analysis. At the advanced and professional level, however, writing is used to make formal contributions to the field by explaining research studies according to the rhetorical conventions decided on by the discourse community; in this case the American Psychological Association. According to my discussion with Dr. Spencer, the course designer and coordinator for Psyc 3530, one purpose of this required course is to help students learn to write a research proposal in accordance with APA standards. After taking Psyc 3530, students are expected to produce papers in this style in subsequent courses. The purpose seems to be to familiarize students with

the conventions of writing and research in the professional realm of psychology, rather than as a practical means for writing up their own research. At the undergraduate level, the goal of a psychology program is to give students a solid foundation in major theories of psychology and major branches of the discipline. Students are not prepared at that level to be designing and conducting extensive, original research projects. This is the fundamental difference between psychology and chemistry that perhaps could be generalized to a difference between physical and social sciences.

In chemistry, at any level, writing serves the same purpose; to clearly explain an experiment so that it can be replicated. All the writing assignments given in chemistry fit this purpose. An essential part of chemistry is experimentation, so from the very beginning students are doing laboratory work to complement what they are learning in the course lectures. The complexity of the experimentation increases as the students move through the program. In the lower division, students are all preforming the same, relatively simple experiments and in some courses (such as Chem 1151/1152) students are not writing a lab report after the lab, but a summary of procedures and expected results to be completed before the lab. In upper division courses, and particularly when students are working independently in a faculty member's research laboratory, the experiments contain more variables and require independent work and thinking in the laboratory. This is actually reflected as a reduction in the number of required writing assignments from the eleven summaries required in Chem 1151/1152 to one or possibly two full laboratory reports required in upper division courses such as organic chemistry (Chem 3100, Chem 3110). Because students in organic chemistry are only conducting one experiment for the entire semester, the required lab reports are longer, fuller, and more complex.

5 ANALYSIS OF WRITING EXPECTATIONS AND EXPERIENCES IN PSYCHOLOGY AND CHEMISTRY

This chapter describes the themes found through the interviews with faculty and students that give insight into the expectations that faculty have of student writing and the experiences that students have with writing for their majors. Though the results of the surveys were not enough to yield significant findings, the surveys were used to complement the themes that emerged from the interviews. The results of the surveys are briefly described followed by the interviews.

5.1 Survey results

The number of responses to the surveys by both faculty and students was not substantial enough to yield significant results. The responses of both faculty and students are presented in the following sections. Though there were too few response for quantitative analysis, looking at the survey results can give a general impression of students' and instructors' perception of reading and writing in their disciplines.

5.1.1 Faculty responses

In psychology twenty undergraduate instructors responded, representing 67% of the total undergraduate faculty. In chemistry seven instructors responded, representing exactly half of the undergraduate faculty. Table 5.1 shows the faculty responses by discipline and instructor level.

Table 5.1 Faculty survey respondents

Faculty	Psychology	Chemistry
Professors	4	1
Associate Professors	2	0
Assistant Professors	8	0
Lecturers	6	6
Total	N=20 (67%)	N=7 (50%)

In psychology, the majority of instructors responded to the survey considering an upper division course, with nineteen out of twenty respondents choosing a course at the 3000 level or above. These

instructors tended to rate their courses as moderately reading intensive, though the majority of respondents felt that careful reading was necessary for success in the course. In terms of what the students are reading in the courses, all instructors responded that textbooks are required and half the instructors also require students to read journal articles from the field. In terms of writing, nearly half (9/20) of the instructors rated their course as "not very" writing intensive, with the same number saying that students do not have to be very good writers to pass the course. Twenty-five percent of the respondents said they always teach writing as part of their course, while the remaining respondents were evenly split between occasionally teaching writing and never teaching writing.

In chemistry, five out of the seven respondents considered a lower division chemistry course. The two additional respondents both considered fundamentals of chemical analysis (chem 4000), the firs CTW course required for chemistry majors. The instructors were fairly evenly split regarding how reading intensive their courses are, though four of the seven felt that careful reading was necessary for success in the course. All the instructors responded that students are reading textbooks in their classes. The two instructors considering chem 4000 also indicated that students are reading journal articles. With regard to writing in the course, these two instructors were the only that considered the course very writing intensive, though only one felt that students needed to be very good writers to pass the course (the other chose "somewhat"). Of the two respondents for chem 4000, one indicated that he always teaches writing as part of the course, while the other sometimes teaches writing. This is noteworthy as part of the course purpose is for students to learn how to write appropriately for chemistry. Only one respondent said he never teaches writing in general chemistry (chem 1211 and 1212).

5.1.2 Student responses

Forty psychology and twelve chemistry students responded to the survey. Although the number of respondents in each discipline was proportional in relation to the total undergraduate population,

about three percent for each discipline, the disparity between the disciplines made comparisons difficult. With such a small percentage of the sample populations responding, any claims based on the data are not likely to accurately represent the total sample. Table 4.2 shows the student respondents by discipline and year of study.

Table 5.2 Student survey respondents

Students	Psychology	Chemistry
1st year	3	0
2nd year	9	1
3rd year	10	3
4th year	17	5
Post Bac	1	3
Total	N=40 (~3%)	N=12 (~3%)

Of the forty student respondents in psychology, thirty-one of them referred to an upper division course, with nine of those responses considering psyc 3530, advanced research design and analysis. The majority of respondents consider the courses reading intensive, with twenty-six out of forty rating the reading a four or three on a four point scale. Thirty-five out of forty students felt that careful reading was important for success in the course. While nearly all students mentioned reading textbooks for their courses, only three indicated journal articles as part of course readings. Considering that most of the students were referring to upper division courses, this response does not match well with the instructors' responses for the similar question. In terms of writing, only thirteen students rated their course as very writing intensive. Twenty-six students rated this question a one or two, the lowest scores on the scale. Only five students felt that students need to be very good writers to pass the course and, interestingly, none of those five students indicated that they felt their teachers always teach effective writing as part of the course. In fact, fifty percent of the respondents said their instructors never teach writing as part of the course.

Unlike the instructor responses, all of the chemistry student respondents considered an upper division course for the survey with two thirds (8/12) basing their responses on organic chemistry (chem 3100). While half of the respondents rated their course as somewhat reading intensive, half also indicated that careful reading was very much necessary to success in the course. Ten of the twelve respondents rated their course as either highly writing intensive or somewhat writing intensive, most likely a reflection of the upper division courses considered for the survey. Half of the respondents felt a student needs to be a good writer to pass their course and nearly all the respondents (11/12) felt that instructors teach effective writing as part of the course at least occasionally.

Because of the differences in department sizes and in the number of responses, it would be inadvisable to make any strong claims based on these survey results.

5.2 Faculty interview findings

Faculty expectations are not isolated top-down mandates on student writing, but are shaped by the performance of the students themselves. While the purpose of these discussions was to understand student writing from the perspective of those teaching in the department, the conversations brought up themes and issues that were not simply expectations, highlighting the complexity of the topic. The process of discussing expectations with faculty during the interviews showed that expectations are not static nor are they easily stated. The interviews revealed instructors' personal struggles with teaching writing, as well as their individual attempts to create solutions. Expectations are dynamic and fluid, depending as much on the instructors' experiences with student writers as the departmental goals. The ultimate expectation of faculty in both psychology and chemistry is realized in end-goals. In chemistry a student should be able to write a professional quality laboratory report by the time they graduate. In psychology a student should be able to demonstrate academic literacy, that is, have some facility with writing a paper in accordance with the American Psychological Association standards, and building a co-

herent argument supported by relevant examples from the literature. Writing expectations at each class level are constructed with these larger goals in mind. The interviews raised important similarities in students' lack of preparation for university writing. This seems to be a campus-wide concern as a mandatory critical thinking through writing (CTW) initiative has been put in place for all undergraduate majors to attempt to address this issue. The next sections will explore the themes from the interviews in psychology and then in chemistry.

5.2.1 Expectations in psychology

The psychology faculty interviews were read iteratively and considered both individually and as a whole. Each reading revealed themes within single interviews which were then compared across interviews. The themes were coded and analyzed. Smaller themes were collapsed into larger themes until four clear themes emerged: students' lack of experience as writers, class size and course purpose, multiple purposes for writing in psychology, and relaying expectations to students. These themes are supported by the survey results and were discussed in depth by individuals during the interviews.

5.2.1.1 Students' lack of experience as writers

When students begin their college careers, instructors expect them to have had experience with some level of academic writing either in high school or in their freshman composition courses. According to the instructors interviewed, many students are not meeting even the basic expectation of writing in complete sentences, with subjects and verbs and without egregious spelling errors. The heterogeneity of students is a particular challenge. Some students come well-prepared and able to write and need only to learn the more discipline-specific aspects of writing for psychology, while other students have problems with the fundamentals of grammar and syntax. The needs of the students at the very lowest end of the spectrum are the most challenging for instructors to address when setting expectations for the class. Dr. Spencer explored several reasons for students' apparent lack of writing experience. In part, she

faults academic faculty for a lack of empathy toward students. Professors write for a living. Many became professors because they enjoy writing in their discipline and have crafted this art over many years. Like a fish in water, some academics can lack the meta-awareness it takes to explain how to think and therefore write in an academically acceptable manner. They do not understand how anyone cannot do this. She discusses students' general inability, or unwillingness to craft an argument and logically support what they are trying to say. In her experience, many undergraduate writers put the communication burden on the instructor. In other words, students will write down their "unprocessed thinking" and expect the instructor to "mine these words for what they meant. It's like as long as you have some words on the paper, I'm supposed to be able to extract your message." In her ten year tenure at the university, she estimates that the average students' reading and writing ability has gotten markedly worse. She muses that the lack of interest or ability in the thinking, revising, and crafting required of academic writing stems from the instant communication to which students are accustomed today. With twitter, e-mails, Facebook statuses, and instant messaging today's students are used to summative sound bites--messages conveyed in 140 characters or less. Dr. Spencer seems to be pointing to a lack of genre awareness in students.

In order to address the needs of the changing population of students, the psychology department developed a course focused on academic writing for psychology. This course was initially established about ten years ago as the second in a sequence of methodology courses and has been through many iterations since that time. The purpose of the original course was to give students experience writing several different types of psychology research papers. Students were required to write four APA style research papers during the length of one semester based on different types of scientific inquiry (e.g. naturalistic observation, and case study). Because of the time constraints and the content load of the course, the papers were based on canned data provided by the professor. The purpose of the course

was to give students a background in scientific writing for the discipline, and presupposed that students were coming to class with a strong foundation in writing (Spencer, personal communication).

This course evolved over the years to better fit students' needs, departmental goals, and now university goals. Currently named Advanced Research Design and Analysis (Psyc 3530), the course is part of the campus-wide Critical Thinking through Writing (CTW) initiative, though meeting the university requirements changed little about the course beyond the class size and the instructor. The major goal of this course is to teach students "scientific literacy" (Spencer, personal communication). Students spend time analyzing sections of professional writing and writing many small assignments that culminate in a final research proposal. Through the iterative process of drafting, the intention is that students will also learn to construct a coherent argument and support their ideas with clear examples from the research literature. This course is not just required, but students are required to pass the course with a 72%. At the time of writing, the department was in the process of creating a mandate that students are only permitted to take the course twice before being required to withdraw from the psychology program.

In response to many students' struggles with the basics of writing, Dr. Collins began a writing lab for psychology students. The priority is to help students in Psyc 3530, the writing intensive CTW course described above. Student tutors are recruited from previous semesters and specially trained to tutor students struggling with the current course. Attempts are made to identify students who struggle with writing in the semester before they enroll in 3530 so they can begin working with a tutor at the start of the course. In most cases, this is not possible. Students are entering Psyc 3530 claiming never to have written an academic paper (Spencer, personal communication). In some cases, the students' problems are so fundamental they would not even be addressed in the stepped and carefully constructed writing instruction of 3530. The goal of the writing lab (in its nascent stages at the time of the interview) is to provide additional support for students who otherwise might not pass the course.

5.2.1.2 Class size and course purpose

The information in the following section comes primarily from my interviews with the undergraduate director, Dr. Rowe, and Dr. Penfold, the department chair. My interviews with Dr. Spencer and Dr. Collins also contributed to this section , but to a lesser extent.

The construction of the undergraduate program has an impact on the amount and type of writing instructors assign to students. At the lower division, there are a number of factors contributing to the lack of writing assignments given. The first is class size. At the 1000 level, the most basic courses are capped at about 120 students (excluding special sections) with approximately 10 sections offered concurrently. Writing assignments are inadvisable in such courses for many reasons. Grading writing assignments for a class of that size is a near impossible task. Students at that level are just beginning college with likely little or no experience with academic writing. In addition, the content of basic survey classes moves quickly and covers many major topics, so writing assignments would not be the most effective measure for evaluating student learning. Furthermore, many students enrolled in psychology courses at the 1000 level are not psychology majors. These courses meet the core requirements for many different majors, so focusing on writing for psychology is not relevant in many cases.

At the 2000 and 3000 level classes are capped at 75 students and are typically taught without an assistant. Again, the class size is prohibitively large to assign major writing projects (though some instructors do require writing in these courses). The courses at these levels are more focused on specific areas of psychology, but the content is dense and requires diligence to compete in one semester. Knowing that students will get focused, discipline-specific writing instruction in Psyc 3530, and that many students have not taken that course yet, makes some instructors reluctant to assign lengthy writing pieces. Most assume that students have not had experience with scientific writing for psychology and therefore make any required writing more generally academic and often personal. Writing assignments tend to be shorter and make up a smaller percentage of the final grade. Again, even at the 2000 and 3000 level, not

all of the students enrolled in a specific course are psychology majors. While instructors might expect all students to be able to construct an adequate academic paper by their sophomore year, expecting students to comply with the conventions of the disciple might be unreasonable.

At the 4000 level class sizes are smaller and course content is focused and in-depth. Courses are capped at 40 students or less and there are fewer sections offered—typically, just one. Students in these classes are usually psychology majors and all will have taken psychology 3530 where they were given explicit instruction on how research is written in accordance with the APA. Instructors tend to assign more writing and more complex papers at this level, though none of the assignments in the focal courses were based on experimental research. Writing also makes up a larger percentage of the grade. Though students are not writing research-style papers, instructors expect them to be able to apply their knowledge of scientific writing to the tasks required in the course.

5.2.1.3 Multiple purposes for writing in psychology

It is not just writing proper APA research papers that is the goal for psychology graduates. Writing serves multiple purposes in psychology, from demonstrating an understanding of course content, to being able to express thoughts in words, to constructing a clear argument (Rowe; Spencer, personal communication). One major, and perhaps primary, expectation of students' writing is that they are able to demonstrate an understanding of the course material by making a connection between the theory learned in class and an experience outside of academia clearly in writing. The application of theory to non-academic experience requires critical thinking and being able to do this in writing demonstrates an understanding of the course material to the instructor. Of course a variation of this skill is also used when writing scientific papers. Researchers need to read and understand the relevant literature and apply it to their current research in a way that conveys the necessity of their research to their peers.

The value placed on this skill is illustrated by the number of assignments in psychology courses at various levels requiring students to write a paper showing a connection or application of theory to an

outside situation. There are courses at nearly every level of study with such assignments included in the syllabus. In Introduction to Applied Psychology (Psyc 2040) students are required to submit three current event summaries in which they find a newspaper or magazine article relevant to a field of applied psychology and explain how the article is an example of an application of psychology. In Interpersonal Behavior (Psyc 3110), students apply two large concepts or theories described in the text or in class to the relationships depicted in one of three films selected by the instructor. Abnormal Psychology (Psyc 3140) requires students to write a diagnostic impression report based on a case provided by the instructor in which they are to apply the knowledge acquired from class lectures and assigned readings to develop a diagnostic impression of the individual. In the same class students have the opportunity to earn extra credit by locating a news article directly relevant to a psychological disorder or topic covered in class and writing a review of the article that summarizes the topic and message of the article, relates the content to the course, and critically evaluates the article. In Social Psychology (Psyc 4020) students write a paper that applies social psychological concepts either to a "real life" situation, another subject area, or a fictional work. Finally, Environmental Psychology (Psyc 4520) has an assignment in which students connect an article in the published source literature in Environmental psychology and an article from the popular media. In fact, the only course in which students are writing a research style paper, as a research proposal, is in Advanced Research Design and Analysis (Psyc 3530). Students are expected to be able to write clear, APA style papers, such as literature reviews or case studies in subsequent courses, but it is unlikely they will write a true research paper at the undergraduate level, as gaining a foundation in the fundamentals of psychology, rather than conducting research, is the focus of the undergraduate program.

5.2.1.4 Conveying expectations to students

This theme was made salient through my interviews with the psychology faculty. Through the process of data analysis, I explored this theme through the responses to the faculty survey, the commu-

nication I had with additional instructors while collecting course materials, and the course materials themselves. Therefore as the theme is discussed below, some of the details are woven together from this collection of sources.

When students are assigned writing in psychology courses, instructors typically give explicit instructions that explain their expectations in several formats. Assignments are first listed in the syllabus with a brief explanation and a grade percentage. Later, as the due date nears, instructors often give students more detailed explanations in class with handouts including a detailed rubric, and a sample paper. According to the instructors I spoke with while collecting course materials, many said they make these handouts available on the course website. In Abnormal Psychology (Psyc 3140), for example, the major writing assignment is a diagnostic impression report. The instructor includes a description of the assignment in the syllabus and later posts a very detailed rubric online with a sheet of guidelines. The rubric itemizes exactly what the instructor expects in each section of the report. For example, in the diagnosis and justification section, an "A" paper will have a correct diagnosis and a justification that accurately matches all major symptoms of the case with diagnosis, earning the student 38 out of 40 points for that section.

This level of explicit instruction is characteristic in psychology and makes sense when the program is viewed holistically. Classes that require writing are often more narrowly focused on a specific field or area of psychology. The type of writing for the course tends to be specific to the course content and the ability level of the students. Most classes are not intended to teach students how to write and, depending on the course level, students may or may not have already taken psychology 3530, the writing focused course. Giving specific instructions and explicitly outlining expectations in a number of formats helps the instructor keep the focus on the content and critical thinking. In other words, if students are given as much guidance with formatting, style, and length as the instructor is capable of, then the student's responsibility is with organizing their thinking in a coherent manner that demonstrates reflec-

tive, critical processing of the course content. In this way, the instructor can remove variables that might separate students simply based on experience level, and try to isolate variables related to what the student has learned in the course.

5.2.2 Expectations in chemistry

Four themes regarding expectations of student writing also emerged from discussions with chemistry faculty: students' lack of experience as writers, the purpose of writing in chemistry, relaying expectations to students, and reading professional writing. Each theme will be discussed in detail in the following section.

5.2.2.1 Students' lack of experience as writers

Chemistry instructors, like their colleagues in psychology, expect students to begin university study with a basic understanding of general academic writing. Also as with psychology instructors, many chemistry instructors voiced their frustration that this isn't the case. Instructors mentioned time and again that some students' problems with writing were fundamental, with egregious grammar errors and incorrect punctuation. Some cited the number of international students attracted to the major as a complicating factor. Students for whom English is a second language sometimes particularly struggle with the rhetorical style of scientific writing, though instructors found non-native writing to be problematic only in severe cases. As Dr. Arnett explains, "A lot of times I won't even see [errors], because I'm not going in there looking for them…if it doesn't distract from the reading, I probably wouldn't even notice."

More disconcerting for instructors is the trend that students who begin the program with writing problems are not showing discernible improvement over two or three courses. Dr. Easton, who teaches both general chemistry and organic chemistry, described his concern that he is not "seeing a dramatic increase in the understanding of the style of writing" between the two courses. Students typi-

cally take general chemistry their freshman year and organic chemistry their sophomore or junior year, at which point they should have had three semesters of chemistry, minimum.

Though students are showing difficulty with some of the style points of scientific writing—using a consistent verb tense, avoiding personal pronouns and using passive voice, for example—the biggest area of struggle, according to instructors, is the results/discussion (sometimes called "conclusion") section of their laboratory reports. The discussion section is where the data is described in prose and the researcher explains error in the experiment and whether their results are consistent with what they could reasonably expect to have occurred. (The importance of the discussion section can be seen in the writing assignments table in Appendix E. Notice the emphasis on the discussion or conclusion.) Dr. Easton explains that students will write well organized and logical procedures, "but when it comes to actually doing data analysis verbally, they just assume that, well, the data's here. I collected all my data and it's in the table above and it came out to this answer." In many ways, Dr. Easton's experience is very similar to the Dr. Spencer's experience with psychology students. She contends students have no interest in crafting a logical argument and instead expect the professor to "mine their unprocessed thinking" for what they meant. "It's like as long as you have some words on the paper, I'm supposed to be able to extract your message." Discussing the data in prose is the section of the paper that requires students to build a logical argument and craft a reasonable explanation for their conclusion. It appears that demonstrating critical thinking in words is difficult for many students.

Perhaps this is a skill that is developed over time with practice, regardless of a student's major. Creating a logical point or coherent argument in words that will clearly communicate the writer's intended meaning is arguably difficult for all writers. Writing takes patience, time and a willingness not to "get it right the first time." Traditional college students at the undergraduate level are developing many skills, including learning the ways of thinking and learning in a specific discipline. Many are also learning to manage their time for the first time and may not budget enough time for process writing. Simplistic,

unprocessed writing is much faster and cognitively easier than demonstrating critical thought in writing. Students may not have much experience with writing in this way and may get frustrated at the amount of concentrated effort it requires. The effort load is increased by a lack of familiarity with the field and the expectations of the instructor. Dr. Dayton, a veteran chemistry instructor said, "I think the biggest problem is that students leave this writing to the last minute and therefore they don't put a lot of effort into writing the report…the section on the results is pretty straightforward, [but] students still don't understand what is meant by a discussion of what they did." He attributes much of this to a lack of experience and possibly maturity, noting that post-baccalaureate students tend to write excellent reports. Chemistry courses like organic chemistry are a pre-requisite for students who are returning to college for a career change or an additional degree. These students tend to be older than traditional students and have more experience both with college and the workplace. This experience and maturity might be the reason such students are perceived by Dr. Dayton as more successful at adapting to a new writing style.

5.2.2.2 The purpose of writing in chemistry

In chemistry there is generally only one type of writing, writing a research report. Whether the writing is professional and published in a peer-reviewed journal, or written for a freshman level general chemistry course, the style of writing shares the same purpose and falls into the same genre. As experiments become more involved and sophisticated, so follows the writing, but in terms of rhetorical style, writing for chemistry tends to follow the same pattern. As undergraduates, chemistry students begin learning this style of writing, or at least are expected to begin writing in this style, from their first laboratory courses usually taken during their freshman year. In the lower division, students begin by writing experimental summaries, which are modified laboratory reports. Certain groups of students, those part of a chemistry or science-based freshman learning community, begin working with scientific research reports as part of GSU 1010, a course for first semester freshman to help acculturate them to university

life. For these specific learning communities, this course gives students mini-research reports with essential information missing, such as a properly formatted table, or missing references. Students are to correctly supply the missing information. These activities help familiarize students with the type of writing they will be experiencing throughout their undergraduate careers in science. As a side note, the only freshman learning communities using this chemistry-based 1010 course are those for national scholars who are attending the university on a full scholarship based on academic merit and those who intend to follow a pre-medical curriculum. These students have self-identified as science majors and have begun university with a strong idea of their intended academic path so starting a science-track as early as possible is easy to understand. Perhaps it is a bit ironic that these "promising" students are getting earlier help and exposure to the rhetorical style of the discipline, while students who are more likely to struggle with writing as a chemistry major are not.

According to Dr. Dayton, the primary goal of writing an experimental research report in chemistry is replication. "To record your results and to be able to discuss them in a meaningful way, that is how science perpetuates itself. Somebody looks at what you did and tries to improve on it. If it's not written down properly they can't even know what you did." Instructors frequently spoke about the role of audience and its importance to replication. The idea is that a person with some level of chemistry knowledge should be able to read a student's report and understand not only the procedural information, but also the student's conclusion based on the results he or she obtained. This is where writing an effective discussion comes in. Students are encouraged to consider an audience of peers who are not in the same course and have no knowledge of the experiment the student conducted. By writing for a general chemistry-educated audience, the author assumes general chemical knowledge, but not context-specific knowledge, thereby providing enough detail for replication without being overly verbose.

5.2.2.3 Conveying expectations to students

Writing assignments in chemistry are generally given in the laboratory manuals. The lab manuals usually include a written explanation of the information to be included in the report with several appendices for students to reference when writing. The appendices often include an example of table formatting and the way data should be written as well as a section by section detailed example of how the written report should look (how it should be formatted and the information to be included in each section as well as section headings). Beyond the laboratory manual, most instructors said that they gave students some in-class instruction regarding their expectations for the final (or medial) report.

Dr. Arnett, for example, who teaches the general chemistry sequence, the first series of courses in which students are writing laboratory reports, explains the format of the report in class. He discusses the need for concise language and tells students to avoid using personal pronouns and active voice. This is also written in the course syllabus. During class he shows students examples of sections of a lab report including data tables. Students are given a handout with the section guidelines discussed in class. He no longer gives students example reports because students tend to copy the example, substituting their data for his. All of the instructors interviewed followed similar practice with similar reasoning. Each said if sample papers are made available to the students, students tend to copy the model exactly.

In upper division courses, professors will also allocate some class time to explaining guidelines for the final report. With exception of the CTW courses, students are not given the opportunity to re-write their papers, though some instructors gave students the option of submitting a draft before the paper due date. Most noted that very few students take advantage of the offer and those who do tend not to need the extra help. Students are not given scoring rubrics and their papers are not returned for reasons related to academic integrity. Students can view their graded papers during the professor's office hours.

In chemistry 4000, the first required CTW course, more class time is devoted to explicit writing instruction. For example, Dr. Arnett provides students with the results section of laboratory reports from previous semesters and asks them whether they could replicate the experiment from the information in that section. If they could not replicate the experiment using the results, they must identify the missing information. This exercise is designed to enable students to understand the purpose of the results section of a lab report. Students write four full reports during the semester, rather than one or two. Each report is graded by a different instructor, and though the reports are not graded by a rubric, the CTW assessment is. The students are informed as to how their reports are graded and given a copy of the rubric to be used. Drafting is a required feature of CTW courses and students are encouraged to submit multiple drafts. Instructors comment extensively on each submission and students are expected to incorporate this feedback into subsequent drafts and successive papers.

Though chemistry 4000 is one of the two designated CTW courses, a requirement of the university, it is also the first in a series of three chemistry courses designed to teach students effective writing. The next course in the series is chemistry 4010, chromatography, followed by chemistry 4190, spectroscopy. The writing becomes less staged as students progress through the sequence; in fact the chemistry 4190 syllabus explicitly states that students must be able to write professional quality lab reports coming into the course.

The second required CTW course is the capstone course and is designed to give students the opportunity to conduct research with a professor in a laboratory setting. Students petition professors based on the laboratory work they are conducting to obtain permission to work in their lab. This course does not contain a lecture component. Writing expectations in this course are conveyed and met on an individual basis through the student's lab mentor, usually an advanced graduate student, who helps with components of the laboratory work and guides the student in writing up their research. The student's writing is also discussed with the lead professor, whose expectations are explained directly to the

student. Students receive a lot of individual feedback on their writing and are given opportunities to re-write their work, if necessary.

5.2.2.4 Reading professional writing

Through their coursework, students are not frequently required to read professional chemistry writing published in a peer-reviewed journal. The time constraints of the semester and the difficulty in finding level-appropriate, relevant articles are often cited as the primary reasons for not including reading from this genre. When asked how students could improve their writing, however, several instructors answered that students should read more journal articles to improve their familiarity with the rhetorical style of the genre. Dr. Dayton was adamant that the only way to improve as a writer is to read the writing of the leading professionals. In his view, students need to take advantage of the "abundance of literature on the marketplace." In his experience, reading journal articles, even those he didn't understand, helped him make the most improvement in his writing as a student. Professional reports help students become familiar with the "process, the style, and the expectations" of the field. Though students are not required to read much professional writing in their courses, he feels professors can help as mentors by finding articles for their mentees and asking them to read them. Professors can help introduce students to the relevant literature outside of the particular course. This type of mentorship and extra reading is likely best suited for the capstone course where students are involved in specific lab work and are able to read literature tailored to the type of work they are doing.

5.2.3 Psychology and chemistry side by side

The themes explored in this section represent the expectations about student writing held by faculty in chemistry and psychology as constructed through our interviews. There are some similarities between the expectations expressed by faculty in both departments. Namely, professors are discouraged by the lack of experience students seem to have with the genre. Professors seem to feel that this is

a lack of knowledge and experience with any academic writing, not writing for the discipline specifically. Furthermore, in both disciplines instructors discussed students' lack of ability to construct an argument. In chemistry, this becomes apparent in thinness of the results section of lab reports.

In psychology, the sheer size of classes and the variety of topics explored has a strong effect on the expectations of the instructors. In large classes, professors are reluctant to require lengthy writing assignments and many feel they do not have time to teach writing in addition to the course content. In chemistry, on the other hand, professors assume that students understand the genre of laboratory reports and are frustrated when students make mistakes they deem basic or simple (e.g. , using first person pronouns).

5.3 Students experience with writing expectations

Looking at faculty expectations of student writers and departmental goals for student writing creates a picture of undergraduate writing in chemistry and psychology from one perspective. Understanding the students' perception of what is expected of them as writers and their experiences learning to meet these expectations is a valuable point of view that broadens the overall scope of the topic. This section refers primarily to the experiences of the students interviewed and to a lesser degree, student responses to the survey. The students interviewed were also survey respondents. As discussed in the previous chapter, the students who agreed to be interviewed tended to be high achieving students who self-describe as good writers. These students demonstrated the metacognitive awareness necessary to critically reflect on their own learning process, though they may not accurately represent the body of undergraduates in chemistry and psychology.

5.3.1 Students in Psychology

Three major themes emerged from analysis of the student interviews in psychology: developing awareness of disciplinary differences in writing, learning to generalize aspects of research proposal writ-

ing to other types of writing in psychology, and the value of reading professional writing for understanding the disciplinary style of psychology. These themes repeated across all interviews, though different aspects of the themes were addressed in detail by different students.

5.3.1.1 Developing awareness of disciplinary differences in writing

Nearly all students interviewed discussed an awareness of the differences between writing for psychology and writing they had done for other disciplines. Some students became aware of this as they started the major writing course in psychology, Psyc 3530, advanced research methods. Amelia, a junior completing 3530 at the time of the interview, said, "I could write for an academic audience before this semester, but I couldn't write for a psychological audience." She described her previous writing as "very weak," saying it "lacked clarity and structure and didn't have a scientific tone to it." Though she gives this harsh assessment of her writing before taking psychology 3530, she also notes that she found writing for general composition courses fairly easy. "I got high marks in all those courses because, I could follow simple directions and put a sentence together, but writing for a scientific audience is completely different, in my opinion." Of the differences she notes clarity, concision, and following a strict structure as those most distinct to writing for psychology. In her experience, psychology writing is scientific and highly writer-responsible in that the writer must be specific when making points, leaving no guess work for the reader. In her estimation, psychology writing is not creative. She defines creativity as being able to take liberties as a writer, and writing long sentences with superfluous adjectives and colorful language.

A lack of creativity was frequently perceived as a key feature of writing for psychology. Lindsay, another student, contends that in psychology writing "creativity is not important. You can use the same word over and over and over again and as long as it's relevant to what you're talking about it doesn't matter. No one is grading you on creativity whatsoever." Marco, also a junior, enjoyed creative writing as a hobby, something he had been doing since high school. He felt comfortable as a writer and had a lot

of writing experience. He found the need to incorporate and evaluate research necessary in writing for psychology challenging because he was unaccustomed to critiquing the work or ideas of others. He questioned his authority to critically evaluate another's viewpoint. "I realized that [for psychology writing] you can't just make stuff up or put in too much of your own opinion. You really have to go off the research."

Edward also found incorporating research one of the more challenging aspects of writing for psychology, particularly using research to support his argument. For Edward, finding a research gap by exploring previous studies seemed the converse of the structural writing scheme he was used to. "It was like a brand-new approach…The goal of my writing was always to prove I think this and A, B, C, & D are my supporting reasons, instead of A, B, C, & D are my supporting reasons, therefore I want to do this study." Edward also mentioned the challenge of straddling disciplines as an undergraduate. While he was taking psychology 3530 and learning to write a research proposal, he was also taking an honor's interdisciplinary literature course on the American home. "In psychology I'm thinking about behaviors and significant findings about different groups and their behaviors, but in this [the literature] class I'm thinking about how do people even talk about things. Not just the thing itself but how is it viewed and how is it thought about. It's so different when I'm writing." Edward feels that for psychology writing he needs to rely heavily on research and include concrete facts and statistics to support his claims, whereas in the literature course an argument is more flexible.

Anna began her undergraduate studies as an English literature major and found her previous experience writing academic papers helpful in a general sense, though it did make disciplinary differences more salient to her. Changing majors, Anna expected differences in the type of writing and was intimidated, because although she knew the two disciplines would be rhetorically different, she did not know what the differences would be. She describes the challenge as trying to "switch into a scientific mindset." In her early writing for psychology, she fell back on her training as an English major, which

netted her feedback on using more precision in her word choice. She also had difficulty paraphrasing ideas that seemed highly scientific to her. As she said, “learning how to paraphrase and…give it a different spin and still keep it scientific was a huge challenge for me.”

For many students the process of understanding disciplinary differences in writing is one learned best through trial and error. Though students agree that instructors in psychology tend to give detailed assignment sheets and discuss expectations for up-coming papers, many misinterpreted what the instructor meant. Unfortunately, the most effective way for understanding writing expectations is sometimes found in an unsatisfactory evaluation of the student’s work. Students who took the initiative to understand their failure to meet their instructor’s expectations reported a greater understanding of their instructor’s expectations resulting in higher scores on subsequent writing assignments and a writing confidence that transferred to other classes. Marco’s instructors were giving him similar feedback on his papers, namely that he was not incorporating enough research. He found this criticism challenging to correct because he was having difficulty evaluating research and either defending or attacking the work of other researchers. He scheduled appointments with two of his professors and felt much clearer on what they were asking for after meeting one on one. In fact, once he understood the expectations his paper grades dramatically improved.

5.3.1.2 Generalizing writing knowledge

All of the students interviewed felt they truly learned to write for psychology in Psychology 3530, Advanced Research Design and Analysis. Teaching students scientific writing for psychology is a major learning outcome listed for this course, with the goal that each student be able to write a full research proposal by the end of the term. The course is designed to help the students achieve basic scientific literacy in the field. Through the course students become familiar with the methods for conducting research in psychology, including research design and appropriate statistical tests, as well as how the discipline is furthered through the academic conversation that occurs in published research. Students

learn the language of psychology and are taught to evaluate research. Throughout the semester students practice these receptive skills by writing drafts of sections of their own research proposal. The students interviewed expressed that examining components of research articles coupled with the iterative process of drafting helped them understand disciplinary writing at a deeper level.

Amelia felt fortunate to have received assistantships that allow her to work in a faculty member's research lab. In the lab, Amelia has a graduate student mentor to help her with her work and particularly her writing. Before taking psychology 3530, Amelia had written several research papers based on her lab work. She learned to write these papers with her mentor. She describes feeling blind during this process and explains learning how to write as being very unstructured. "They [lab mentors] don't have a syllabus. They don't have a way of structuring what they're teaching you. My first research project that I ended up writing was kind of thrown together." While Amelia appreciated the help of her mentor and valued her experience in the lab, she found the process of writing up research "very confusing" until she took psychology 3530. In her advanced research design class she explains that the professor described the purpose behind each section of the paper, starting from the beginning with the literature review. "[He] was like, ok first we do a literature review, then we look at these articles and see what these articles did and see how we can implement them into our own question…whereas in the lab it's like let's look at the data and see kind of what we want to ask and see if we can form a question and then run some tests and see if they're significant and then we'll write them all up. In fact, it was a very confusing way to do research or write papers because you're starting at the end and then working your way backwards."

Though students, at least those interviewed, felt they learned to write for psychology through the advanced research design and analysis course, the course teaches a very specific type of writing, namely a research proposal. In most cases students will not write a research paper again in their time as undergraduates. Though the purpose of the course is to help students develop psychological literacy,

the writing they learn in the course is not directly applicable to the types of writing required in other courses in their major. It is necessary then, that students also develop an awareness of the differences in writing tasks and are able to appropriately apply the skills developed in psychology 3530 to other writing assignments. Edward touched on this point saying, "I haven't done a research proposal for any other course, but I do remember the certain phrases to use, the way you interpret findings, the way you say something and being concise with it. In my classes now I've done interviews. I've done critiques of articles and their findings, and I've done introspective writing."

5.3.1.3 Reading professional writing

Reading professional writing, usually in the form of published articles in peer-reviewed journals was cited by most students interviewed as being very helpful to their learning the rhetorical style of writing for psychology. Students found that professional writing in the field, even if the content was beyond their level of understanding, served as an effective model they could follow for writing. Marco advised reading published writing on specific topics to become familiar with how that topic is talked about between psychologists. He found reading so helpful to his understanding of disciplinary writing, he wished he had started much earlier than his junior year. Edward felt that professional writing was his window into the style of writing for psychology. He tried not only to model his writing after the experts, but to think like them. "I just got into that state of mind. What kinds of words did they use in those articles, and how did they say it? I think I kind of just modeled after the articles that I read." Rather than relying on published writing to provide a holistic impression of psychology writing, Lindsay used published writing more explicitly, mining journal articles for phrases, move structure, and genre differences. For her, when writing for psychology, "The big key is to look at other research and see how people have phrased this and how people have phrased that and when did they put '*the hole in the research is*…' and '*it's important to look at this because*…' Where did they put that in their papers? Reviews are different

than articles and you have to look at each one and see…" Through reading professional writing, she became aware of genre differences within the discipline and applied this awareness to her own writing.

Though reading professional writing like published journal articles seems to be beneficial from the students' perspectives, such reading is not a mandatory part of the curriculum until advanced research design and analysis (Psyc 3530), a class most students take during their junior year, at the earliest. There are other classes that include professional writing in the syllabus, but these classes are not required. In the focal classes selected for this study, only 4000 level courses and psychology 3530 required students to read scholarly journal articles. Both Marco and Anna suggested that reading professional writing earlier in their studies would have benefited them. Anna said she would encourage students to take 3530 as soon as possible, while Marco thought the emphasis on analyzing professional writing in 3530 would have been even better at the 2000 level.

There are numerous reasons why instructors are not including professional journal articles in their syllabuses at the 2000 or 3000 course level. Students are new to the major and finding level-appropriate readings is difficult. Though students may benefit from exposure to the rhetorical mode of the discipline through reading such materials, the purpose of these courses is not to explicitly teach students about writing for psychology. For course instructors, these difficult readings serve no obvious purpose. Typically courses at this level offer a survey of psychology or a field of psychology and are content-driven, rather than skill-focused. With the large amount of dense content to successfully cover in a semester, there does not seem time nor value in additional readings which may not further a student's understanding of the course content. The problem with this perspective, and this was noted by instructors, is that the burden of teaching disciplinary understanding for writing and research falls on one course. This course, psychology 3530, is skill-focused, but instructors are feeling the gravity of being solely responsible for giving students a thorough understanding of how to write for psychology. Many

students enter the course having no concept of what a journal article is, or what professional psychology writing looks like, having never been exposed to it previously.

5.3.2 Students in chemistry

The themes that emerged from the interviews with students in chemistry are: writing is taught as an iterative process, but expectations are idiosyncratic, the value of reading professional writing to understand the disciplinary style, and laboratory work is most helpful for developing writing skills.

5.3.2.1 Writing is taught through an iterative process, but expectations are idiosyncratic

In order to explore this theme of writing and expectations, it is necessary to first look at the structure of the undergraduate program from a macro perspective to understand how writing fits in the program as a whole. Most chemistry courses are divided between theory and application. The theoretical portions are taught lecture style and assessed through examinations with multiple choice questions and problem sets. The practical application portions are laboratory work with a shorter lecture and student experimentation. This section is assessed through participation in the lab, accurate, complete and properly formatted laboratory notebooks, and laboratory reports. At the lower division laboratories are part of the general course and provide twenty-five percent of the total course grade. At the upper division laboratories may be additional courses worth two credits and are ideally taken concurrently with a theoretical course in the same area. The theoretical and practical sections of a course or topic are rarely ever taught by the same instructor. The structure of these two different components is vastly different, with the theoretical component being quite passive and the practical component being very physical. All writing in chemistry takes place in laboratory courses. Writing is often a small part of the total course grade as it is only a fraction of the total laboratory grade. Since writing is only a small component of what students need to be successful as chemistry majors, it is also a small component of what is taught.

In the students' experiences, writing instruction is limited to the pre-laboratory lecture. Before an assignment is due, instructors typically spend class time discussing the expected format for the paper with the students. Students are usually given guidelines with the expected sections outlined as well as the type of information that should be included in those sections. The guidelines often include specific instructions for formatting tables according to the American Chemical Association standards. Some instructors show students sample papers from past classes or papers written on different topics, though the students interviewed found the samples minimally helpful. As discussed previously, instructors are reluctant to give students copies of the sample papers because of their experiences with student copying. Because the sample papers are usually written on different experiments, also to avoid the temptation to copy data, students find the examples difficult to relate to. This seems particularly true if the example paper is deemed "severely failing." Students, not knowing the specifics of the experiment in the paper, have a difficult time finding "failing" points that are generalizable to their own writing. Instructors also remind students not to use personal pronouns, to use passive voice, and to keep their writing as concise as possible (as vague an instruction as that may seem).

The students I spoke with found the guidelines and instructions clear for writing their reports. They attempted to avoid personal pronouns and tried to think in a "cold, scientific" (Daniel) manner to keep their writing direct and concise. Though they felt confident writing the paper, most reported receiving a grade lower than they expected on their first attempt. In the interviews, students were specifically referring to organic chemistry (3100) in which a midterm and a final report are required, and the fundamentals of chemical analysis (4000) the first CTW course in which students write four papers, most likely because these are courses they were currently taking or had taken very recently. This would seem to indicate a misunderstanding of the expectations for writing the reports, and, indeed the professors interviewed felt the first reports in these courses were frequently poorly written. Several students had the sense that they would have gotten a low grade on the first paper regardless of what they turned in,

simply because at their level, they would always have problems. According to Richard, in organic chemistry "everybody got a pretty bad grade on the first paper and the second paper we'd all redeem ourselves because we understand how we're supposed to write, and the same thing with analytical chemistry (4000)." With reference to organic chemistry, he also contended, "I don't think [the instructor] wanted to give anyone a good grade on the first paper. I knew whatever I submitted to [the instructor], [he] would think it's horrible." While that was frustrating to Richard during the course, he feels in retrospect he would agree with the professor's assessment of his writing. Contradictorily, Richard did not attribute the poor grades to a mismatch of expectations. "I think we did meet his expectations. I think that he just said that we did terrible so that we would do better." For John, this approach was defeatist rather than motivating. He felt the professors in chemistry 4000 were very up front about telling students their first papers would be graded severely and they likely would not do well. Because of this, he did not put forth much effort on his first submission, knowing he would have the opportunity to submit a revision.

After the initial submission, students receive feedback on their papers and many also discuss their weaknesses with their instructors. Typically, the feedback and discussion helps bridge the gap in understanding and the students usually execute a stronger paper the next time around. This iterative process, particularly in chemistry 4000 allows students the chance to practice their writing, something John found valuable to learning. He liked the immediate feedback he received on his papers and the chance to talk with the instructor to find ways of reorganizing his writing and his thoughts.

While many instructors seem to embrace the iterative process as a way of teaching writing in chemistry, their expectations for writing often seem idiosyncratic to the students. This is interesting, because, unlike psychology, writing in chemistry tends to be the same type with the same purpose (a lab report), a version of which students have been writing since high school. Students seem to find an instructor's expectations difficult to understand before they have submitted a paper because they can

vary greatly from professor to professor. For some students this seems compounded by the lack of continuity they feel between their theoretical and practical coursework. Each is taught by a different professor who emphasizes different aspects of the course. Students find bridging the theoretical and practical in their papers difficult because they do not see continuity between the topics in their courses. In chemistry 4000, the lecture and laboratory components are each taught by several different instructors throughout the semester with as many as four instructors teaching the lecture portion and two instructing the laboratory. Each of the four papers written during the semester is graded by a different instructor. While this gives students a chance to learn from different professors and cuts back on the grading load for the instructors, students find determining what each instructor expects a challenge. Sometimes the challenge is deciphering the written feedback on their papers and understanding enough to incorporate the feedback into the next draft. Several students noted that the level of detail expected by one particular professor was considered "too much" by other instructors and would be marked down in a paper. In some cases students found the feedback pertained only to their formatting and not to the content of their paper, though they lost credit for their content as well. Another student, however, discussed receiving feedback on content and format and found it clear and helpful.

5.3.2.2 The value of reading professional writing to understand the disciplinary style

Realizing the idiosyncrasies of each professor, Richard developed a technique for better understanding what professors were most interested in. At the start of the semester, he asks his professors what professional journals they most often read. He then uses the format of articles in those journals to guide his writing. He found looking at the style of journal articles helpful even if he did not understand the content of the article. This leads to the next theme present in the interviews; the value of reading professional writing to understand the disciplinary style. Every student interviewed discussed the importance of reading professional journal articles to their understanding of chemistry writing. The aspects of writing students say they struggle with most are sentence level structure and word choice. Students

understand, or claim to, the organizational purpose of each section. They understand the information that should be included in each section. They lose confidence when it comes to the actual writing. They find choosing the appropriate phrasing to express themselves challenging. As new writers in the field, they are often faced with expressing concepts in words that they have not previously experienced. They are just building their scientific lexicon and being new to the field, they have not been frequently exposed to the ways in which common, yet complex, scientific processes or concepts are expressed in writing. Several students reported the usefulness of reading journal articles to their finding appropriate phrasing in their research reports.

John noticed that since he began reading journal articles his scientific lexicon has grown steadily. "I have read a ton…in terms of language, that's helped. The first journal I read, it was the summer of freshman year, I understood maybe one percent of what I read. I really had to go research like every term I saw and really the more you start reading the easier it gets, and I guess at this point it's hard to even look back…because now I can read them pretty fast." Through reading journal articles, John feels his chemistry literacy has improved. He says has become more efficient at skimming for specific information because he is familiar with how articles are organized. He also claims has become a more effective writer both through his implicit knowledge of chemistry writing and through explicitly looking for similar language within published chemistry reports.

According to the students interviewed, they are required to read very little professional writing in their courses. A few students taking upper level courses were reading and responding to journal articles and one student who transferred from another university read and summarized journal articles in his general chemistry courses. For the most part though, students are not required to read professional, published writing.

Students usually begin reading published material when they begin their research courses, working in a laboratory under the direction of a senior faculty researcher and a graduate student mentor. Both Richard and Leah noted that their laboratory mentors were the first to give them published research to read. They discussed this research with their mentors or in some cases together with the other researchers during lab meetings. One semester of research is required for all chemistry majors as a capstone seminar and is the second required CTW course. Many students, however, begin laboratory work early in their careers and continue for several semesters.

5.3.2.3 Laboratory work for developing writing skills

The personal setting of the laboratory is where most students interviewed say they felt they learned to write for chemistry. Each student is required to write a scientific report at the end of the semester detailing their work in the lab. For both John and Daniel the content of these papers made them easier to write. “I don’t have to write papers on research that other people are doing. I write the paper on what I’m doing...it’s my own stuff” (Daniel). These students felt more invested in the work they were doing as one part of a large-scale research project and felt that their work was important. They were more motivated to write about their research than in some laboratory classes where they felt the experiments bore little point beyond a pedagogical one.

Each student is assigned a graduate student mentor in the lab. The mentor provides guidance and support at the individual level for all aspects of the student’s work in the laboratory. The one-on-one attention from the mentor relationship as well as the availability of the faculty researcher is an environment conducive to the development of student researchers. Many of the students interviewed cited their lab mentor as the most influential person in their development as writers. For many, their first experience writing for chemistry was in the laboratory. John credits his mentor with changing his perception of how to write for chemistry. He wrote a draft of his first paper and showed it to his mentor who gave him feedback on a better organizational style. John describes his original organizational scheme as

linear, meaning he followed the chronological steps of the experiment he outlined in his laboratory notebook. This seemed, to him, the most logical way to set up his paper, in fact, John admits he had never considered the possibility of something different. His lab mentor suggested a different organization and explained why following a chronological progression might be tedious and confusing for the reader. Chris also noticed that chronology was rarely the priority for organizing research reports in the literature.

It is interesting to note that this same positive view of the mentor relationship with regard to learning the rhetorical style of the discipline is not shared by Amelia, a psychology student who worked in an equivalent laboratory setting. In her experience, she did not feel she truly learned to write for psychology until she took the first CTW course (Psyc 3530). She found her experiences writing with her mentor confusing and counter-intuitive. This is a near opposite experience to the chemistry students, who found the first CTW chemistry class (Chem 4000) confusing and haphazard, but felt they more fully began to understand chemistry writing through their mentor relationship and working in the laboratory setting.

5.4 Summary

This section will first compare and discuss the experiences of students across psychology and chemistry and then compare the instructors' expectations and the students' experiences in each discipline.

5.4.1 A comparison of students' experiences across psychology and chemistry

While students' experiences writing for their discipline certainly have similarities between psychology and chemistry, there are important differences between the disciplines that are worth exploring. The first major and arguably most important difference is in their perception of the assigned writing tasks. In psychology, students seem to perceive of writing tasks as isolated assignments. While students

are more likely to make connections between assignments within a course, they seem reluctant to draw associations beyond the boundaries of a specific class. Because of this, students expect to be given explanations and examples of major writing assignments. They also feel that for some assignments they have to learn by "trial and error." Students will assume they understand what the instructor expects and students learn how close they were when they receive their grades. When students find they did not match their instructor's expectations, they reported positive experiences meeting with the instructors to discuss their work in more detail. In these meetings, students felt the professors were very clear and gave specific instructions for improvement. The students interviewed did not seem to consider writing as situated in a discipline until they took Advanced Research Design and Analysis (Psyc 3530). Many of them consider this course the turning point in understanding the purposes behind writing for psychology. After taking this class, students discussed drawing on their awareness of psychology writing developed in Psyc 3530 in subsequent (and concurrent) classes.

Chemistry students, on the other hand, perceive of their writing assignments as basically the same type across all their classes, with good reason as the assignments all fall under the umbrella term *lab report*. They also seem to consider the writing discipline specific, generalizable perhaps to physical sciences. The apparent similarity across writing belies the differences both nuanced and overt that may exist between assignments. Students tend to run headlong into these differences when submitting lab reports without fully considering the context of the course and requirements of the instructor. Because the assignments are essentially from the same category, students do not expect detailed explanations or assignment guides from their instructors. Some students interviewed expressed frustration with expectations, finding them idiosyncratic. Students did not find meeting with instructors as easy or helpful as the psychology students described.

A second meaningful difference between the experiences of students in psychology and chemistry was their own perception of their writing experience. In psychology, students tended to describe

themselves as inexperienced writers. Several claimed they had never written a paper before taking Psyc 3530 and point out that writing is rarely required in their courses before their third year of study. This may reflect the students' beliefs about what qualifies as an academic paper. Most, if not all, of the students interviewed had taken freshman composition and all had taken courses that have writing assignments. In fact, they were able to describe the writing assignment in classes other than Psyc 3530. On the whole, however, students felt they did not have a lot of experience with writing for psychology. The students interviewed had all taken, or were in the process of taking, Psyc 3530, a course which seems to cause an eye-opening paradigm shift in students' perceptions of writing for psychology. After taking this course, students seem to develop an acutely different idea of what it means to write for psychology, and may classify all previous writing as poor or uninformed.

Chemistry students, conversely, tend to self-describe as experienced at writing for chemistry, finding the writing they do for their courses analogous to the physical science writing they did in high school. Students overall felt that their writing improved in style and sophistication as a result of working with a student mentor in their research lab classes more so than in their CTW classes. This is the exact opposite of what Amelia experienced in the psychology lab. She found her lab mentor's suggestions for writing up her research confusing, while she had a very positive experience with writing instruction in her CTW class.

This finding might be reflective of epistemological differences between the way chemists and psychologist view the role and relative importance of writing in their disciplines. In psychology, as will be discussed in detail in the next section, instructors recognize writing as being central to the field, though not necessarily the top priority for undergraduates. They expect to have to explicitly teach students how to write for psychology at some point in their undergraduate program. Psyc 3530 reflects this expectation by focusing on explicit teaching of the disciplinary method for writing up psychology research. Chemistry instructors, on the other hand, based on our discussions, do not seem to consider writing an

essential part of their discipline. They expect that students have some experience writing lab reports before they begin their course of study. Chem 4000 (the chemistry equivalent of Psyc 3530) is designed to give students practice and feedback through the quantity of writing, but does not have an explicit focus on teaching students how chemistry research is written-up. Writing is taught in this course, but not to the extent it is taught in psychology. Students, therefore, get more individualized and explicit disciplinary writing instruction through their graduate mentors in the lab.

5.4.2 The gaps between instructors' expectations and students' experiences

Several of the differences between psychology and chemistry students described above are also germane to a comparison of instructors' expectations and students' experiences within the disciplines. The largest gap between instructors' expectations of student writing and students' experience in psychology seems to be in defining discipline-specific writing. The instructors in psychology do not seem to consider most writing assignments in psychology as necessarily discipline-specific. When interviewed, instructors expected students to be able to write in a generally academic manner and cited grammar, organization, and argument as the most important areas for student writing. These qualities are similar to those found as generalized academic standards for writing in Thaiss and Zawacki (2006). Instructors did not expect to have to teach students these qualities of general academic writing, but did expect to teach writing for psychology. As a course was designed specifically for this purpose, (Psyc 3530) instructors of 3000 level and lower courses tend to create assignments they feel do not require disciplinary writing knowledge. Based on the interviews, this usually means assigning writing that does not require following APA (American Psychological Association) standards. Students, however, seem to have a different perception of discipline-specific writing. While the students interviewed acknowledged Psyc 3530 as teaching them how to write for psychology, their confusion with writing expectations in their other psychology classes might indicate that these assignments are implicitly discipline-oriented even beyond the instructor's awareness. As has been pointed out both in the literature and in my interview with Dr.

Spencer, professors are often so steeped in the rhetorical conventions of their disciplines, that they are not aware of the "rhetorical peculiarities of discourse in their own disciplines" (Thaiss & Zawacki, 2006 p.32). This may also be the reason psychology students describe themselves as lacking writing experience—they had not experienced the type of writing assignments they encountered before they took classes in psychology.

In chemistry, the largest discrepancy between the writing expectations of professors and students also involves the nature of discipline-specific writing. In this case, though, the frustration seems to come from terminology. Students and professors seem to believe they have a common understanding of the meaning of the writing type, *lab report.* The writing students have been producing throughout their science classes in high school and college has all been classified as *lab reports.* Because of this, it seems that professors expect students to understand how to write in this genre. There is also a sense that both students and professors feel lab report writing is very straight-forward and somewhat secondary to the experiment itself. The professors interviewed described the results section as the most problematic for students. They felt that many students had difficulty moving from the more procedural sections to the more analytical sections, like the results. Although this could certainly be due to a lack of experience and will develop over time, it could also be due in part to a lack of clear standards and explicit instruction in writing. While some professors reported taking time in class to explain exactly what information should be included in each section, they do not demonstrate the rhetorical strategies used to by chemists to write a results section, nor do they provide examples for the students to look at beyond what they show during class. As a result of this misunderstanding, students tend to see instructors' expectations in chemistry as opaque and idiosyncratic.

6 ANALYZING READING AND WRITING IN PSYCHOLOGY AND CHEMISTRY

The present chapter describes the analysis of course readings and student writing in psychology and chemistry. The results of the multidimensional analysis of each corpus (course readings and student writing) are explored through Gray's (2011) four Dimensions in sections 6.1-6.4. Section 6.5 gives a summary of the results describing the linguistic features of writing in each corpus.

Analyzing the course readings in psychology and chemistry alongside student writing will provide a clearer description of the reading students are doing, their major source of disciplinary language, and the writing they are producing, which we might expect to be quite different. Multidimensional analysis has been chosen as the methodology because of the effectiveness of this method for demonstrating quantitatively how linguistic features of different registers tend to co-occur. Undergraduates, certainly in the two disciplines involved in this study, receive little explicit disciplinary writing instruction outside of their first CTW course. This course is typically taken in third year of the program, often in the second semester. As described in chapter 4, psychology students learn to write an APA research paper, something rarely assigned outside Psyc 3530. In chemistry, students did not find the writing focus of Chem 4000 very helpful in learning to write for the discipline. Because students are not given much discipline-specific, explicit writing instruction or practice, it is important to look at what types of disciplinary writing they are exposed to. The largest and most consistent form of disciplinary writing input comes from course readings. In psychology, textbooks are the primary source of discipline specific writing input. Students do read journal articles in Psyc 3530 and some other courses, but these articles are usually chosen by the students, and therefore difficult to assess as the articles are not the same. In chemistry, students are reading textbooks and laboratory manuals in equal proportions. Students read published articles, particularly in their research classes, but again they are different for each student.

The following four sections of this chapter will analyze the dimension scores for each corpus on each of the four dimensions, beginning with Dimension 1, comparing scores both across register and

discipline and looking more closely at how dimension-specific linguistic features are realized in each register. Excerpts are included to demonstrate the use of linguistic features for each dimension. The excerpts have been coded with a tag denoting the discipline, course number, and text type. For example, an excerpt from the psychology 4020 textbook would be coded (P_4020_TB), while an example from the chemistry 3100 lab manual would have the code (C_3100_LM). Student writing is denoted with the final letters SW.

6.1 Dimension 1: Academic involvement and elaboration versus informational density

Conrad (1996) looked at academic texts including ecology and history textbooks, student research papers and published journal articles using Biber's (1988) dimensions. While she found distinct differences between academic writing and other registers of English for Dimension 1, involved vs. informational production, the scores for the academic texts were rather close together and highly negative, meaning they are informationally dense. As discussed in section 3.2.4, this study will follow the four dimensions formulated by Gray (2011). Because Gray's (2011) Dimension 1 is based only on academic writing, distinctions between both register and discipline appear that might not otherwise be apparent using Biber's (1988) dimensions.

Dimension 1 (Gray, 2011) highlights the differences between registers of academic texts by sifting out those with a high ratio of linguistic features that are associated with informational density from those that have linguistic features associated with academic involvement. These two groups of features (see Table 6.1) occur in complementary distribution, meaning the environment in which one set of features frequently occurs is unlikely to also have a high frequency of the other group of features. To illustrate the disparity between the two groups of features, they are considered as opposite ends of a spectrum, or dimension.

Table 6.1 Linguistic Features for Dimension 1
Adapted from Gray (2011)

Positive Features	
Pronouns:	nominal pronouns, pronoun *it,* 1st person pronouns, demonstrative pronouns
Nouns:	nouns of cognition
Adjectives:	predicative adjectives, evaluative attributive adjectives
Verbs:	verb *be,* verb *have,* causative verbs
Modal Verbs:	modals of prediction, modals of possibility, modals of necessity
Adverbs:	general adverbs, stance adverbials, adverbials of time
Conjunctions:	subordinating conjunction—conditional, adverbial conjuncts, subordinating conjunctions
Finite Clauses:	*that*-clauses controlled by nouns of likelihood, *that*-clauses controlled by verbs of likelihood, *that*-clauses controlled by factive adjectives, *that*-clauses controlled by attitudinal nouns, *that*-clauses controlled by factive nouns, *wh*-clauses
Non-Finite Clauses:	*to*-clauses controlled by stance adjectives, *to*-clauses controlled by verbs of probability
Negative Features	
Nouns:	nouns, process nouns
Verbs:	past tense verbs
Passives:	passive postnominal modifiers, agentless passive voice verbs
Other:	prepositions, type-token ratio, word length

One set of features, in this case those that show involvement, are considered to be on the positive end of the dimension, while the other set of features, those showing informational density, are said to be on the negative end. Positive and negative linguistic features in multidimensional analysis are not referring to occurrence or absence, but rather to a factor loading for each feature showing the propensity for co-occurrence within the same environment.

Two major trends are immediately visible by looking at the plotted dimension scores in Figure 6.1. The first is that psychology as a discipline demonstrates more academic involvement in both the course readings and the student writing, while both registers in chemistry are on the negative end of the scale, showing a preference for more informationally dense writing.

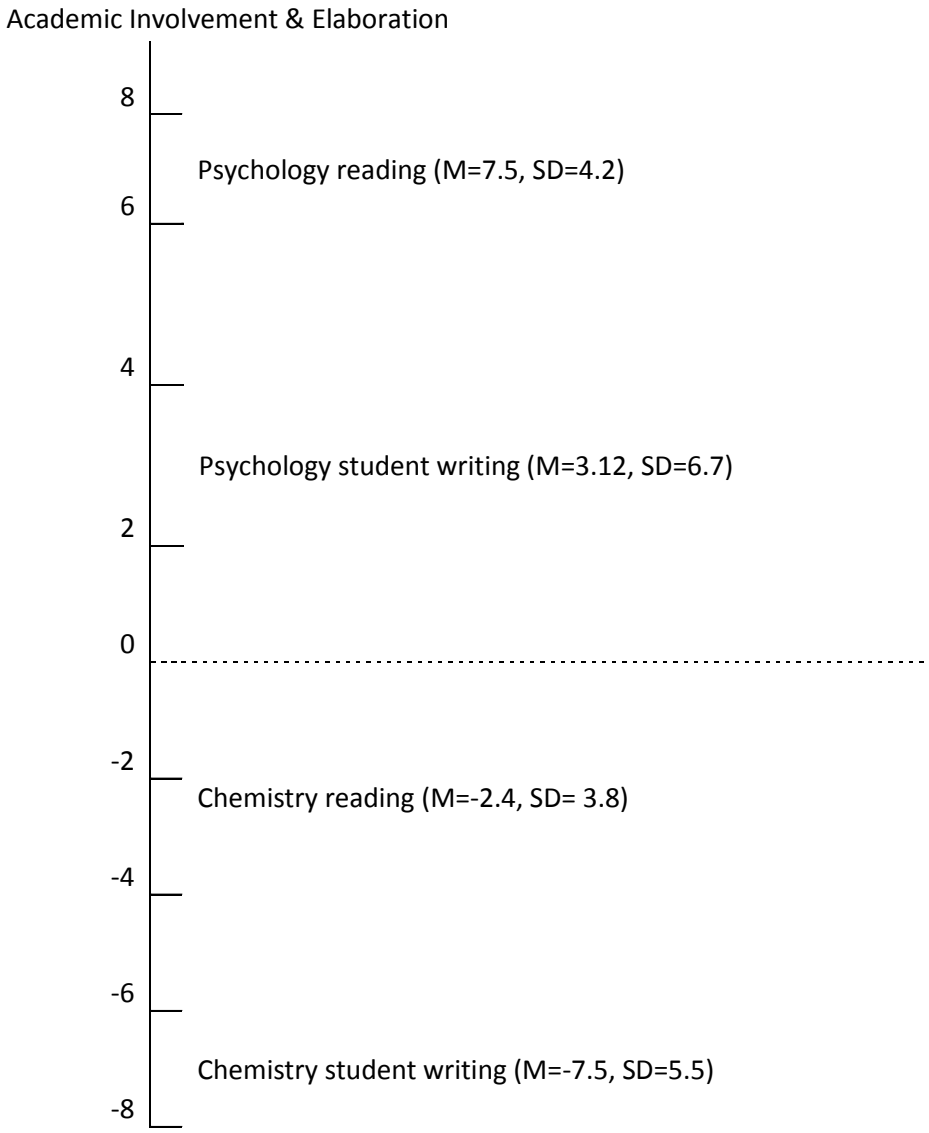


Figure 6.1 Distribution of registers and disciplines along Dimension 1: Academic involvement and elaboration versus informational density. Independent samples Kruskal-Wallis test: p=.000

Perhaps it is not surprising that a physical science like chemistry would have strong negative scores for Dimension one as this was also found by Gray (2011). In addition, though Conrad (1996) found negative scores for academic texts in both history and ecology, the ecology scores were more largely negative. The second is that in both disciplines the student writing has lower scores than the course readings. This is due to the differences in the purposes for each text. Writing that has large positive scores for Dimension 1 uses linguistic features such as pronouns, modifiers, and personal stance markers that give a sense of the author's personal involvement with a text and invite the reader to become involved as well. Undergraduate textbooks assume a low level of background knowledge of the reader and are intended to initiate novices into the discipline. Textbooks tend to include more general discussion of topics and examples to which the reader might easily relate. "As a consequence, informational characteristics are less densely packed in textbooks and their Dimension 1 score is higher" (Conrad and Biber, 2001, 100). The course readings in psychology had a mean dimension score of 7.5; not an extreme score, but certainly exhibiting the more positive features of this dimension (see Table 6.1). As discussed previously, the psychology reading corpus is comprised entirely of textbooks barring one book geared toward a general audience and one very short journal article. It is perhaps interesting to note that the general audience book had the highest positive score of all the texts while the journal article had the lowest score. This shows that journal articles are linguistically quite different from textbooks that students are reading based on the distributions along Dimension one. The excerpt below from the psychology readings corpus (PRC) is marked for the positive features of this dimension. *It*, nominal, and first person pronouns are double underlined. *Be, have*, and causative verbs are in SMALL CAPS. General adverbs and predicative and evaluative adjectives are underlined. Modals of prediction, possibility, and necessity are *italicized*. *Wh*-clauses are underlined with a dotted line. Nouns of cognition are underlined with a broken line. Subordinating conjunctions are bold underlined and clausal structures are indicated with a **bolded** head word and corresponding [brackets].

6.1 Let's add up the **elements** of social cognition **[**we've encountered in this chapter.**]**In a close relationship, partners *may* hold idealized but overconfident perceptions of each other, and when they ACT in accord with those judgments, they *may* ELICIT **behavior** from each other**[**that fits their expectations but which *would* not have otherwise occurred.**]** Moreover, right or wrong, they ARE likely to interpret one another's actions in **ways[**that fit their existing preconceptions.] Combined with all this ARE the partners' efforts to adjust their behavior so that they MAKE the **impressions** on each other**[**that they want to make.**]** Evidently, there ARE various **processes** at work in intimate partnerships **[**that CAUSE us to see in our partners**]** those **attributes and motives[**that we expect or want (or that they want us) to see.**]** How accurate, then, ARE our perceptions of our partners? How well do we know them? (P_3110_TB)

This excerpt reveals the general tendency shown by this type of text that the language is somehow less academic than what would be expected in more discipline specific genres such as the research article, for example. Dimension one identifies exactly what linguistic features are causing this impression. There are a striking number of pronouns, particularly first person plural pronouns (*we, us*), that directly invite the reader to become involved with the text and with the development of the content of the chapter. There are also a number of clausal structures which convey personal stance. Looking at an excerpt from the psychology student writing corpus (PSWC), we see fewer positive features. (The features have been marked in the same manner as above.)

6.2 Politicians and political rhetoric HAVE the **ability [**to socially **construct** positive and or negative groups**][**to best **fit** their personal agenda**][**to acquire votes.**]** In contrast to a large senior voting population who *would* be positively constructed, non naturalized immigrants who have no political power ARE more **likely[**to become scapegoats and negatively constructed**]** resulting in the

negative stereotypes. It IS this negative **construction [**that allows the **voice** of prejudice and discrimination**][**to enter into the voting process**]** out of public eye. (P_4020_SW)

Not only are there fewer positive features overall in example 6.2, the features that are used are different from those used in the textbook. First person pronouns do not occur in this excerpt. The pronouns used are demonstrative or *it* (positive features), or are third person (not a positive feature). The writer uses evaluative adjectives and general adverbs as well as a number of *to*-clauses. It seems the positive features used serve the function of indicating the author's stance, a more implicit form of involvement, rather than the explicit involvement demonstrated in the psychology textbook excerpt.

As might be predicted, both chemistry registers have negative mean scores on Dimension 1. The chemistry reading corpus (CRC), a corpus comprised of equal numbers of laboratory manuals and textbooks, has a mean dimension score of -2.4 indicating that the texts are not strongly informational, but do employ a substantial number of negative features. Consider the excerpt 6.3 from an organic chemistry textbook in which the negative features are marked as follows: nouns are underlined, prepositions are **bolded**, past tense verbs are *italicized,* passive constructions are double underlined, and passive postnominal modifiers are in SMALL CAPS .

6.3 Although this possible mechanism seems reasonable, it's not completely consistent **with** known facts. In particular, it doesn't explain the stereochemistry **of** THE ADDITION REACTION. That is, the mechanism doesn't tell which product stereo isomer is formed. When the reaction is carried out **on** a cycloalkene, such as cyclopen-tene, only the trans product isomer is formed rather than the mixture **of** EIS AND TRANS ISOMERS that might have been expected if a planar carbocation intermediate were involved. We say that the reaction occurs **with** anti stereochemistry, mean-

ing that the two bromine atoms come **from** opposite faces **of** the double bond one **from** the top face and one **from** the bottom face. (C_2400_TB)

In passage 6.3, the use of nouns, prepositions, postnominal modifiers and passive voice contribute to giving this passage informational density. The only feature not found is past tense. Past tense is associated with narrative and because chemistry, and this passage in particular, deals with states and facts, there is a preference for present tense. That the CRC has a negative mean score for Dimension 1 does not necessarily indicate a lack of positive features. Excerpt 6.4 (below)is marked for positive features. Again, *it*, nominal, and first person pronouns are double underlined. *Be, have*, and causative verbs are in SMALL CAPS. General adverbs and predicative and evaluative adjectives are underlined. Modals of prediction, possibility, and necessity are *italicized*. *Wh*-clauses are underlined with a dotted line. Nouns of cognition are underlined with a broken line. Subordinating conjunctions are bold underlined and clausal structures are indicated with a **bolded** head word and corresponding [brackets].

6.4 The basic techniques are so easily **learned [**that it IS **tempting][**to use them in a purely mechanical 4, rote fashion.**]**However, you *should* aim for a higher standard. In any new situation, to select the most appropriate process and to employ it effectively, you *must* understand the principles involved as well as the correct methods of manipulation. This book starts with distillation because the principle of vapor pressure on which it depends IS familiar to you from your freshman chemistry course. The immediate goal here IS to understand how vapor pressures of mixtures depend on the structures of the components and how, in turn, the vapor pressure controls the distillation behavior and separation efficiency. (C_3100_TB)

In the first half of excerpt 6.4, the textbook author is directly addressing the reader, specifically a student who has already taken a freshman chemistry course and has some chemistry knowledge. The author uses a number of evaluative adjectives and adverbs as well as the modals *should* and *must.* Outside of the two final *wh*-clauses, the end of the excerpt does not have any positive features and is also where the author begins to talk about the chemical process of distillation.

Perhaps it is not expected that chemistry student writing, the purpose of which is to convey procedural information about an experiment, would display many of the positive features of involvement and, indeed, the mean dimension score is correspondingly negative. In excerpt 6.5 from the chemistry student writing corpus (CSWC), the negative features of Dimension 1 have been marked to illustrate how they function to make the text more informationally dense. Nouns are underlined, prepositions are **bolded**, past tense verbs are *italicized,* passive constructions are double underlined, and passive post-nominal modifiers are in SMALL CAPS .

6.5 The 2,4-dinitrophenolhydrazonetest*was* performed to determine if the carbonyl *was* a ketone or aldehyde, or another carbonyl group. Acetone, a ketone, *was* used as a positive control. When the test *was* performed **with** acetone, an orange precipitate *was* produced. When the neat liquid *was* tested, an orange liquid *was* produced (Table 1). Then, the hydroxamate test *was* performed. When a known ester *was* used as a positive control, a burgundy color *was* produced. A burgundy color *was* also produced when the neat liquid *was* tested (Table 1). Finally, the bromine test *was* performed to determine if the unknown *was* an alkene. When a known alkene *was* used as a positive control, the sample *turned* colorless. When the unknown *was* tested, it *turned* red (Table 1). (C_3100_SW)

Excerpt 6.5 contains a large number of highly specific nouns and only one pronoun (*it*). All of the verbs are past tense and all main clause verbs except one (*turned*) are passive voice constructions. The pur-

pose of this excerpt is to clearly explain the procedural steps taken to test an unknown chemical compound and describe the observed results of the tests. There is no acknowledgment of the author's personal stance, nor acknowledgement of the reader in the manner illustrated in both the chemistry and psychology texts.

On Dimension 1, academic involvement and elaboration vs. information density, there is a clear divide between psychology and chemistry. Psychology, in both the course readings and the student writing show more features of academic involvement and elaboration, often to acknowledge the writer's personal stance, for example. In the course readings, which are primarily textbooks, the positive features also serve to acknowledge and include the reader in the text. Chemistry, on the other hand, demonstrates less involvement and a higher information density. The course readings, however, do use features of involvement and elaboration primarily to acknowledge the student reader. Chemistry student writing shows high information density with a large number of nouns and passive voice constructions. There is no reference to personal stance or involvement of the reader.

6.2 Dimension 2: Contextualized narration vs. procedural description

Gray (2011) found Dimension 2 to reveal differences in the way disciplines present evidence. In her study, there was a clear divide between disciplines (or sub-disciplines) that follow a qualitative research paradigm and those that are quantitative in their approach. Qualitative research tends to involve more narrative than quantitative research, which usually presents evidence in a more procedural manner. This general trend appears to hold true for the data in this study. The linguistic features for Dimension 2 are presented in Table 6.2.

Table 6.2 Linguistic Features for Dimension 2
Adapted from Gray (2011)

Positive Features	
Pronouns:	3rd person pronouns
Nouns:	group nouns, nominalizations, animate nouns
Adjectives:	topical attributive adjectives, attributive adjectives indicating time
Verbs:	past tense verbs, aspectual verbs, perfect aspect verbs, communication verbs, present progressive verbs
Conjunctions:	phrasal coordinating conjunctions, clausal coordinating conjunctions
Finite Clauses:	*that*-relative clauses, *that*-clauses controlled by non-factive verbs, *wh*-questions
Non-Finite Clauses:	*to*-clauses controlled by verbs of modality, causation and effort, *to*-clauses controlled by verbs of desire, *to*-clauses controlled by stance nouns
Other:	word length, word count, type-token ratio
Negative Features	
Nouns:	technical nouns, quantity nouns, concrete nouns
Adjectives:	attributive adjectives indicating size

As is evident from Figure 6.2, psychology as a discipline is on the positive end of the spectrum, while chemistry is near the negative pole. However, this apparent relationship warrants a closer examination for several reasons. First, psychology as a discipline is not inherently qualitative. Much of psychological research is quantitative in its approach. The second has to do with the type and purpose of the texts included in each corpus. The reading corpora in both psychology and chemistry primarily contain textbooks (and laboratory manuals in the case of chemistry) the purpose of which is to introduce novices to the central concepts, theories, and researchers in a particular field, and not necessarily to present research. The student writing corpus in both disciplines may have more of a research-style orientation, but as described in Chapter 4, undergraduate students are not usually conducting novel research nor is the purpose of their writing usually research based. Beginning with an examination of the psychology readings corpus (PRC), reveals different types of writing within the same text. Two excerpts have been included from the same chapter of a social psychology text in the PRC. Both are marked in the same manner. Third person pronouns, group nouns, and animate nouns are underlined. Past tense, progressive

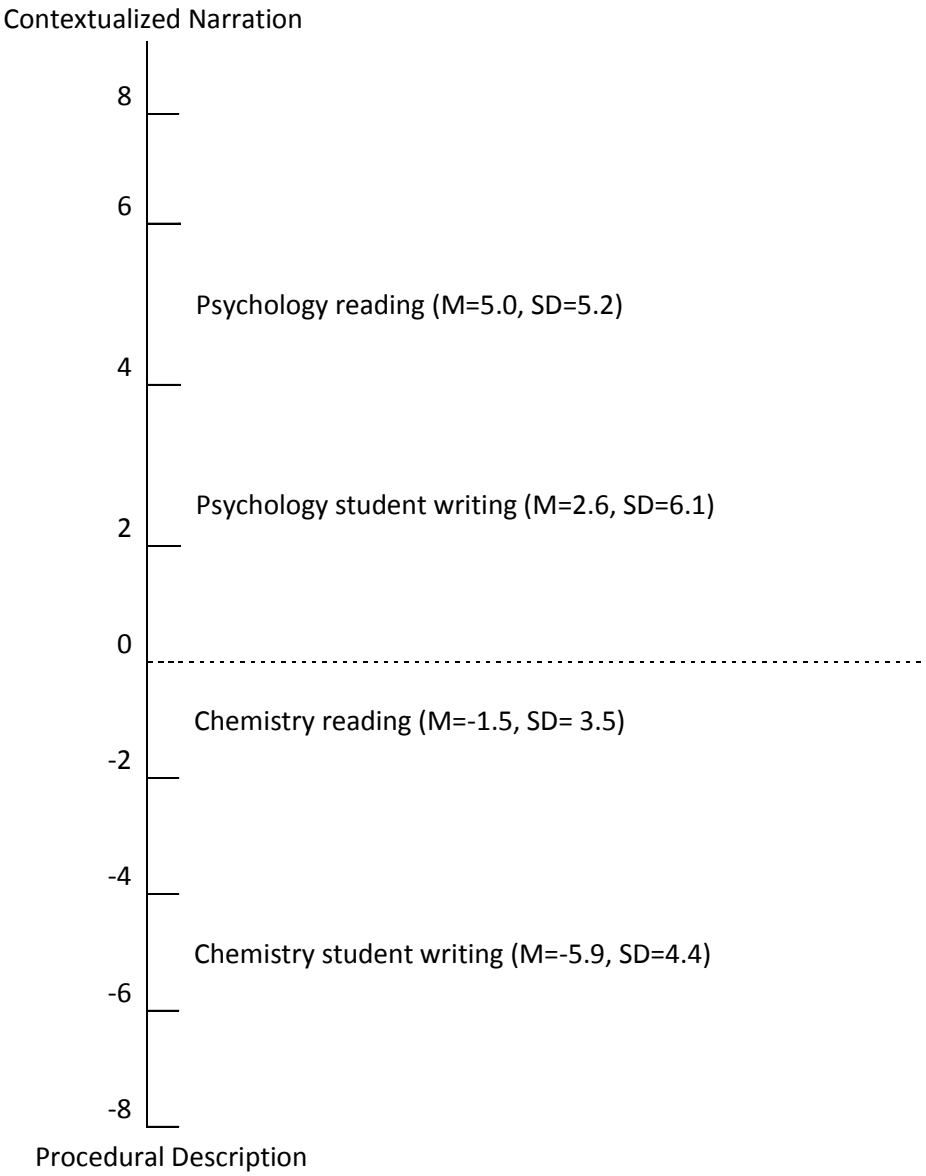


Figure 6.2 Distribution of registers and disciplines along Dimension 2: Contextualized narration vs. procedural description. Independent samples Kruskal-Wallis test: p=.000

aspect, and perfect aspect verbs are **bolded**. Conjunctions are *italicized*. Non-finite *to*-clauses controlled by verbs of modality, causation, effort, or desire are double underlined. Excerpt 6.6 is taken from the beginning of the chapter.

6.6 Walter Gretzky, the father of hockey great Wayne Gretzky, **has** always **considered** himself to be a lucky man. *But* on October 13, 1991, at the age of 58, his luck almost **ran** out. Walter **was painting**, when he suddenly **felt** dizzy *and* **developed** a splitting headache. He **wanted** to go to his room *and* lie down for a while, *but* a friend of his daughter's **was visiting** *and* insisted on driving him to the hospital. She almost certainly **saved** his life. Walter immediately **underwent** 5 hours of emergency surgery for a burst blood vessel on the surface of his brain. The **reduced** blood supply to his brain **caused** a stroke. Strokes are the leading cause of disability in the United States *and* the third leading cause of death. Approximately 700,000 Americans suffer a stroke each year. (P_4020_TB)

This excerpt is straight narrative. The author is telling the story of a person's personal experience with stroke. The person is the father of a well-known sports star, whose name at least is probably familiar to the target audience (i.e. North American college students). The first seven lines, where the story is being told, contain a high number of positive feature nouns and third person pronouns and all the main verbs are in past tense with some also having progressive or perfect aspect. The last two lines contain only one positive feature, the noun *Americans,* but this is also where the narration ends. These sentences are giving factual information and are not part of the story. This technique, using a narrative to introduce a new chapter or topic and get the reader interested, seems a particularly useful tool for textbooks in the social sciences. Comparing excerpt 6.6 from the beginning of the chapter to excerpt 6.7 (below) from later within the same chapter, illustrates a dramatic change in the way in which language is used.

6.7 Schemas are mental representations of objects or categories of objects (Fiske & Taylor, 1991; Hastie, 1981; Smith, 1998). You possess distinct schemas for apples, fathers, your own father, justice, robins, the moon, danger, your social psychology professor, and countless other things. Another term that is sometimes used for schemas is concepts (see Kunda, 1999; Medin, 1989). Schemas or concepts contain mental representations of objects or categories, which contain the central features of the object or category as well as assumptions about how the object or category works. Your schema for apples probably includes the points [that they are red and grow on trees.] (P_4020_TB)

There are strikingly few positive features used in this excerpt, though that is not necessarily an indication of the excerpt relying on more procedural discourse. Below, the same excerpt (6.7) is marked for negative features. Concrete, technical, and quantity nouns are **bolded** and passive voice constructions are underlined.

6.7 **Schemas** are mental representations of objects or categories of objects (Fiske & Taylor, 1991; Hastie, 1981; Smith, 1998). You possess distinct **schemas** for **apples**, **fathers**, **your own father**, justice, **robins**, **the moon**, danger, **your social psychology professor**, and countless other things. Another term that is sometimes used for **schemas** is **concepts** (see Kunda, 1999; Medin, 1989). **Schemas** or **concepts** contain mental representations of objects or categories, which contain the central features of the object or category as well as assumptions about how the object or category works. Your **schema** for **apples** probably includes the points that they are red and grow on trees. (P_4020_TB)

The primary negative features in this excerpt are concrete and technical nouns, with one passive voice construction. These two excerpts were selected to demonstrate the lack of homogeneity in textbook language use. Within a chapter a textbook may move from narrative to procedural, or in this case, something in between. Overall, the PRC has a mean dimension score of five, indicating that on the whole, the reading students are doing for psychology exhibits more features of contextualized narration than procedural discourse. Student writing in psychology has a lower, but still positive, mean dimension score of 2.6. Excerpt 6.8 (below) from the PSWC is marked for positive features in the same manner as above.

6.8 Just as behavior can affect attitude, attitude can affect behavior. This can happen in many different ways. For instance, an attitude (or feeling) can be specific to a behavior. In the film Mel Gibson **treated** his daughter differently than he **treated** the other women in his life. It is possible [that this can be attributed to his feelings (attitudes) toward/for his daughter.] Attitudes can dictate behavior when these feelings are obvious. For example, at the end of the film Mel Gibson **went** to Helen Hunt *and* **told** her everything [that **happened]***and* what he **had done** for her. This demonstrates that attitude can shape behavior when feelings are clear. If Mel Gibson's character did not have feelings about Helen Hunt's character than he probably would not **have done** what he **did**. (P_4020_SW)

Excerpt 6.8 is a juxtaposition of summary and analysis. The positive features of Dimension 2 appear when the writer is giving a summary of a film. When the author is giving commentary on the main character's actions, the positive features drop off—the verb tense changes from past to present and third person pronouns as well as animate nouns are seldom used. This excerpt comes from a social psychology paper in which the assignment was to "apply one or two social psychological concepts to a 'real life'

situation, another subject area, or a fictional work"(psychology 4020 syllabus). This assignment is in the category *connection of theory and data,* though assignments in *summary/reaction to a reading,* and *case study* would likely show linguistic similarities as each would require a narrative summary interspersed with commentary or analysis from the writer. These three categories taken together represent 82% of the assignments in this study.

It seems that in psychology textbooks and student writing, contextualized narration is more of a literal storytelling that can be separated from other sections of the text. In textbooks, such stories seem to occur at the start of a new chapter or topic to catch the reader's interest. In student writing, narrative linguistic features are usually a part of a summary for which the student then provides commentary. This use of the positive features of Dimension 2 expands Gray's (2011) findings based on journal articles, where she found for qualitative research, these features were used to set up a narrative that would substantiate and explain the author's interpretations.

Both chemistry course readings and student writing have negative mean scores for Dimension 2, indicating a propensity for procedural discourse. As students are reading about chemical processes and reactions and writing up reports to explain experiments, the use of procedural language might be expected. There is a gap between the average dimension scores in the CRC (M= -1.5) and the CSWC (M=-5.9), with the student writing scores four points lower than the mean reading dimension score. As discussed in chapter 5, chemistry student writing is primarily in the form of laboratory reports in which the student explains the precise procedure followed in an experiment and explains the results of the experiment. Students are encouraged to use passive voice, use specific terms (concrete and technical nouns) and to avoid personal pronouns (Easton, personal communication). These are all negative features for Dimension 2. Excerpt 6.9 (below) from organic chemistry illustrates the use of negative features for Dimension 2 in student writing. Negative features: Concrete, technical, and quantity nouns are **bolded**. Attributive adjectives indicating size are *italicized,* and passive voice constructions are <u>underlined.</u>

6.9 During the fractional distillation of the **mixture**, the **boiling point** of the **low boiler** was found to be 1000C. The **fractions** of the **low boiler** were run through a **GC** in order to ensure the purity of the **compound**, and the **GC** for the **low boiler** can be found in **figure 5.3**. After the **compound** was deemed pure, an **IR spectrum** (**figure 2.1**) was taken to aid in the rest of the process. Through the other **tests** the **RI** was found to be 1.392 and the **density** was found to be 0.7064 g/mL. For the low boiling component of this **mixture** a **MS spectra** (figure 2.3) was also taken to aid in the identification. **Chemical test** were performed based on the results of the **IR spectra** (results **figure** 4) and when the **silver nitrate** test was performed, the **compound** was determined to be an **alkane**. (C_3100_SW)

All of the main clause verbs in this excerpt are agentless passives, with the writer as the unnamed agent. There are also a large number of technical and highly specific nouns. The purpose of this section is to precisely describe the exact procedure followed to obtain the results. Comparing the use of the negative features in this excerpt with the negative features in an excerpt from the CRC shows some differences in the ways in which the features are used.

6.10 **Iodine** itself is unreactive toward aromatic rings, and an oxidizing agent such as **hydrogen peroxide** or a **copper salt** such as **CuCI2** must be added to the reaction. These **substances** accelerate the iodination reaction by oxidizing I2 to a more powerful electrophilic **species** that reacts as if it were I+. The aromatic ring then reacts with I+ in the typical way, yielding a substitution **product**. Aromatic rings can be nitrated by **reaction** with a **mixture** of concentrated nitric and sulfuric **acids**. The **electrophile** in this **reaction** is the **nitronium ion**, **N02+,** which is generated from **HNO3**by **protonation** and loss of **water**. The **nitronium ion** reacts with **benzene** to yield a **carbo-**

> **cation** intermediate in much the same way as **Br+**. Loss of **H+** from this intermediate gives the neutral substitution **product**, **nitrobenzene** (**Figure** 16.5). (C_3410_TB)

Again, there is a strong use of passive constructions in this excerpt, however, several of them have *by*-phrases. In addition, active voice is also used. The agents of the verbs, whether active or passive, are all non-human (this will be discussed further in the next section on Dimension 3), unlike the unnamed agent in the student writing excerpt. This passage is not explaining the steps of an experiment, it is describing the chemical properties of certain compounds and their reactions to other chemicals. Though there are several negative features of Dimension 2 present, they are fewer than in the student writing, and serve a different function.

6.3 Dimension 3: Human vs. Non-human focus

The linguistic features for Dimension 3 distinguish between writing that has a human vs. non-human focus (see Table 6.3). That the polarity observed in the previous Dimensions is also apparent between the disciplines for Dimension 3, with psychology on the positive end and chemistry on the negative, is perhaps unsurprising as psychology is the study of the human mind and behavior, while chemistry studies the physical properties of chemical compounds. It might be expected that a discipline with the human at the core of its investigation would also exhibit linguistic features demonstrating a human focus in writing and vice versa.

Table 6.3 Linguistic Features for Dimension 3
Adapted from Gray (2011)

Positive Features	
Pronouns:	2nd person pronouns, 3rd person pronouns
Noun:	process nouns
Verbs:	mental verbs, activity verbs, communication verbs, present progressive verbs
Finite Clauses:	*that*-clauses controlled by factive verbs, *wh*-clauses
Non-Finite Clauses:	*to*-clauses controlled by verbs of desire, *to*-clauses controlled by speech verbs
Negative Features	
Adjectives:	attributive adjectives, attributive adjectives indicating topic
Adverbs:	general adverbs
Other:	prepositions

Looking at the registers within the disciplines shows that the register scores are much closer together for Dimension 3 than previous dimensions. This is especially true in psychology where the difference between the mean dimension scores for course readings and student writing is only 0.3 (see Figure 6.3), with student writing having a slightly higher score.

In the following excerpt from the PRC, third person pronouns and mental, activity and communication verbs are the most frequently occurring positive features. (Process nouns and 2nd and 3rd person pronouns are **bolded**. Mental, activity, and communication verbs, and present progressive verbs are *italicized*.)

6.11 If, recognizing **their** differences, people thoughtfully keep **their** disagreements to **themselves** and *allow* **their** partners to do as **they** wish, **they** may *avoid* conflict that would otherwise occur if **they** *confronted* each other with **their** differences. On the other hand, if people have to give up something that **they** want because of **their** partners' influence, conflict exists. Anger and hostility aren't necessary; **we** make some sacrifices to accommodate **our** partners generously and happily. And not all conflicts are overt; one partner is sometimes unaware of the difficulties **he**

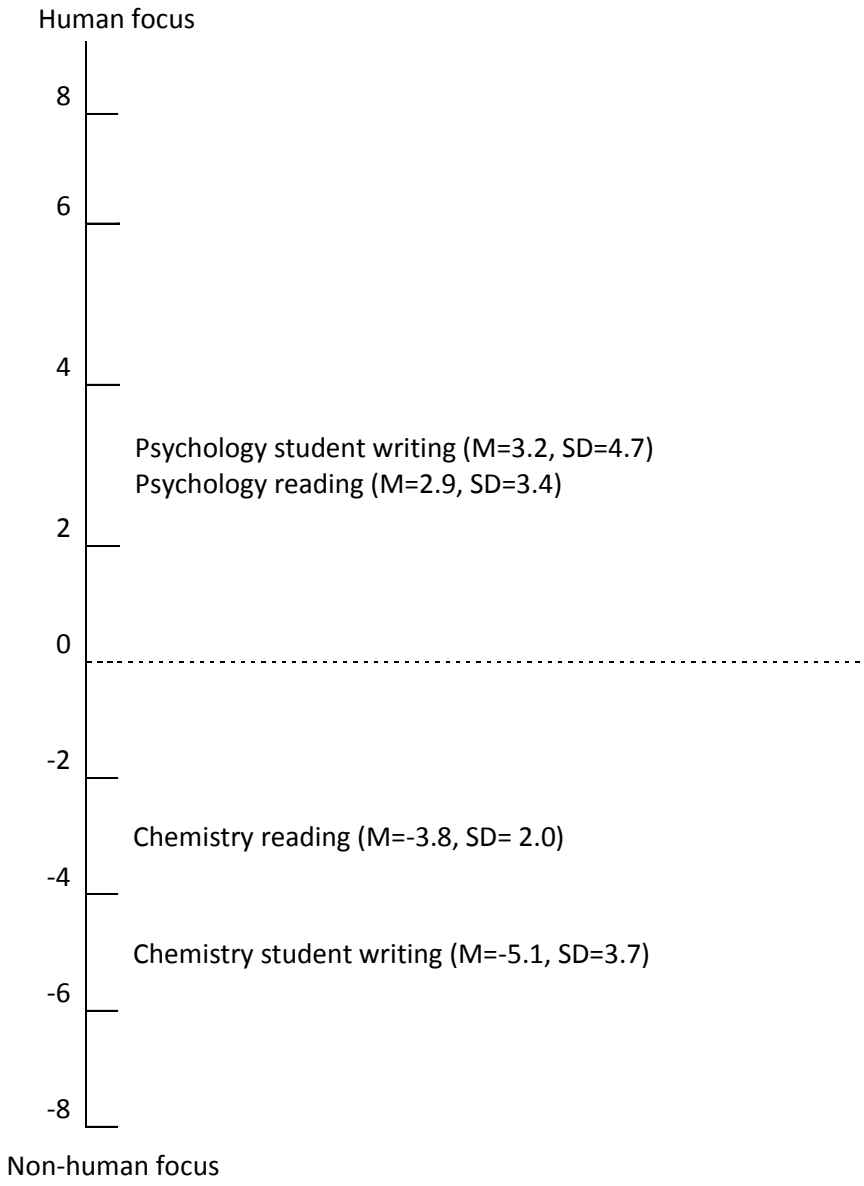


Figure 6.3: Distribution of registers and disciplines along Dimension 3: Human focus vs. non-human focus. Independent samples Kruskal-Wallis test: p=.000

or **she** *is causing* the other (Fincham & Beach, 1999). It's enough that someone knowingly or unknowingly *prevents* another from getting or doing everything **he** or **she** wants. (P_3110_TB)

The passage 6.11 is explaining conflict in relationships with the third person pronouns referring to non-specific people. The mental and activity verbs all have the generic "people" as their agent. In excerpt 6.12, from the PSWC, there is a higher use of mental, activity, and communication verbs, and *wh*-clauses while fewer pronouns are used.

6.12 The grieving **process** of surviving parents may make it difficult to assist **their** children. During the first year after spousal death, grieving is strongly related to difficulties with psychological adjustment (e.g., going to work) among adults (Ott & Lueger, 2002). Moreover, the first few months after a parent *dies* are considered a critical time for adolescents to *seek* help. Generally, this is when adolescents *are most willing* [to *express* **their** feelings and emotions] (Harris 1991). If adolescents do not *seek* help, **they** might *experience* increased anxiety levels, decreased involvement with peers, and a decreased interest in school (Black, 2005). Few experts in grieving support have *provided* information to families, school officials, and the community about why it is important to *provide* organized bereavement support to adolescents (Auman, 2007). (P_3530_SW)

Psychology as a discipline is inherently human-focused and that is reflected in both the course readings and student writing to nearly the same degree.

In chemistry, there is an obvious lack of human focus. In both the CRC and the CSWC there is a high use of attributive adjectives and prepositions as well as a lack of positive features. In excerpt 6.13 of student writing below, the negative features have been marked, but it is worth noting that second or third person pronouns are not used, nor are there any mental or communication verbs or present pro-

gressive verbs. The negative features have been marked as follows: attributive adjectives are underlined, general adverbs are **bolded**, and prepositions are *italicized.*

6.13 Fluorescence is a dominant methodology used **extensively** *in* biotechnology, medical diagnostics, DNA sequencing, forensics, and genetic analysis. Fluorescence, or spectrofluorometry detection is **highly** sensitive, and a type *of* electromagnetic spectroscopy which analyzes fluorescence *from* a sample (1). In fluorescence spectroscopy, the species is first excited *from* its ground electronic state, *by* absorbing a photon, to one *of* the various vibrational states *in* the excited electronic state (3). Collisions *with* other molecules cause the excited molecule to lose vibrational energy *until* it reaches the lowest vibrational state *of* the excited electronic state. (C_4190_SW)

The only verb in excerpt 6.13 with an implied human agent is *analyze* (line 3) in which *electromagnetic spectroscopy,* the name of the field, stands in for a human. In excerpt 6.9 from the CSWC discussed in section 6.2 (reprinted below), the writer used many verbs that had an implied human agent, but used them as agentless passive constructions. Most, if not all, of these verbs are mental or activity verbs, positive features for Dimension 3. In procedural discourse, such as the procedures section of a laboratory report, the agent is not the central focus, the process followed is. Agentless passive constructions are used to remove the human and highlight the procedure, though traces of the human subject remain in the types of verbs that are used. Despite the use of positive feature verbs, the absence of other positive features, such as pronouns and stance markers, and the use of negative features such as attributive adjectives, adverbs and prepositions, contribute to the strong non-human focus of chemistry student writing.

6.9 During the fractional distillation of the mixture, the boiling point of the low boiler was found to be 1000C. The fractions of the low boiler were run through a GC in order to ensure the purity of the compound, and the GC for the low boiler can be found in figure 5.3. After the compound was deemed pure, an IR spectrum (figure 2.1)was taken to aid in the rest of the process. Through the other tests the RI was found to be 1.392 and the density was found to be 0.7064 g/mL. For the low boiling component of this mixture a MS spectra (figure 2.3) was also taken to aid in the identification. Chemical test were performed based on the results of the IR spectra(results figure4) and when the silver nitrate test was performed, the compound was determined to be an alkane. (C_3100_SW)

The CRC showed fewer negative features than the CSWC, though they are still present. The negative features of Dimension 3 are marked in the excerpt below (6.15) from a laboratory manual. Again, attributive adjectives are underlined, general adverbs are **bolded**, and prepositions are *italicized.*

6.15 At a specified temperature, the density *of* a pure substance is a constant property and it can be used to identify a particular element or compound. Therefore, the density *of* a substance is **routinely** used *to* great benefit. For example, the high density *of* gold *in* comparison to that *of* other minerals allows gold to be separated *from* other materials *by* agitating an aqueous mixture *in* a pan with sloping sides. The less dense materials such as sand are more **easily** stirred up than are the gold particles. Thus, the less dense materials are washed out *of* the pan when it is swirled under water and the gold is concentrated *on* the bottom of the pan. This same principle is used **commercially** to isolate dense metals such as iron and copper. (C_1152_LM)

The primary negative features used are attributive adjectives and prepositions. This excerpt is explaining the significance of density and ends with an example describing the process of panning for gold. In the example section, agentless passive constructions are used with activity verbs, similarly to the procedure section from the student writing sample discussed above. Again, though there are more negative features than positive features, and a particular absence of pronouns indicating the non-human focus of the writing.

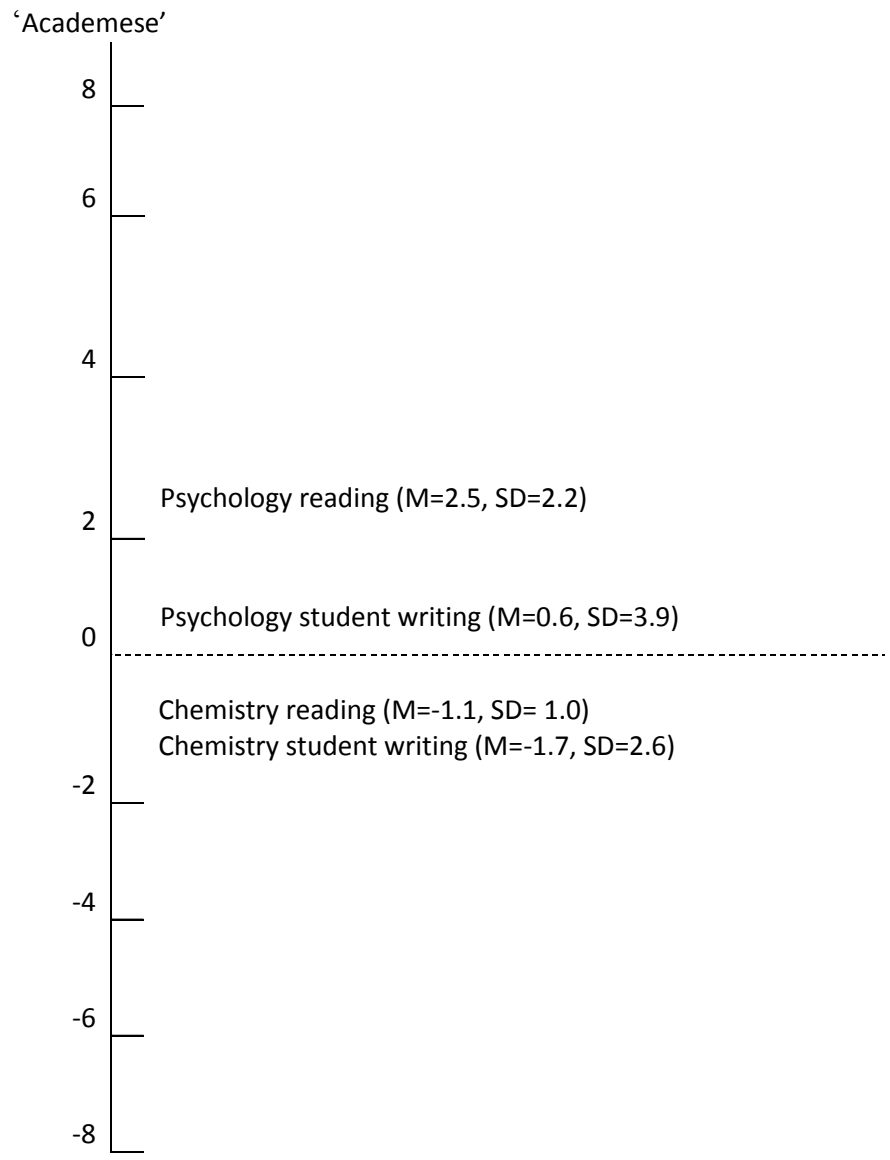
6.4 Dimension 4: 'Academese'

Dimension 4 looks at the use of features of overtly academic language such as nominalizations, abstract nouns, and existence verbs (see Table 6.4). As Gray (2011) discusses, very few features are included in this dimension (8 positive and 1 negative) making interpretations based on the findings preliminary, at best.

Table 6.4 Linguistic Features for Dimension 4
Adapted from Gray (2011)

Positive Features	
Nouns:	nominalizations, process nouns, other abstract nouns
Adjectives:	relational attributive adjectives
Verbs:	existence verbs
Finite Clauses:	*that*-clauses controlled by likelihood adjectives, *to*-clauses controlled by stance adjectives
Other:	word length
Negative Features	
Adverbs:	time adverbials

There is a divide again on this dimension between psychology and chemistry, with psychology on the positive end and chemistry on the negative (see Figure 6.4) though the spread of the dimension scores is rather small. In fact, none of the dimension scores for either discipline or register are extreme. Gray's (2011) analysis suggests that registers and disciplines with positive scores for this dimension may overtly mark the scientific nature of inquiry in the field, as she found positive scores primarily for social



Procedural Description

Figure 6.4 Distribution of registers and disciplines along Dimension 4: 'Academese.'Independent samples Kruskal-Wallis test: p=.000

sciences. This analysis may be interpreted as true for my data, with psychology course readings showing more explicit marking of the empirical nature of research with a mean dimension score of 2.5. It is difficult to make any substantial claims in this vain, however, because the purpose for textbook writing is vastly different than the purpose for writing academic journal articles, the register Gray (2011) studied. In the excerpt from the PRC below, there are rather few positive features. Nearly all the positive features are abstract nouns and relational adjectives. Positive features for Dimension 4 are **bolded** (nominalizations, process nouns, other abstract nouns, relational attributive adjectives and existence verbs).

6.16 The theoretical approach that dominated psychology in the late 1800s and early 1900s was called structuralism. According to structuralism, our **overall experience** is determined by combining **basic** elements of **experience** called **sensations**. Thus, just as chemistry had developed a periodic table of the elements, which organized elements on the basis of their molecular weights and chemical properties, Wundt wanted to create a "periodic table of the mind," which would include all of the **basic** sensations involved in creating **experience**. Wundt thought he could achieve this by using analytic introspection, a technique in which trained participants described their **experiences** and thought processes in response to stimuli. For example, in one experiment, Wundt asked participants to describe their **experience** of hearing a five-note chord played on the piano. Wundt was interested in whether they heard the five notes as a **single** unit or if they were able to hear the **individual** notes. (P_4100_TB)

Even fewer positive features are found in psychology student writing as it has a dimension score near zero. The two chemistry registers have very similar negative scores and exhibit few negative features as can be seen in excerpt 6.17 from the CSWC below. Time adverbials, the only negative feature, are **bolded.**

6.17 A simple distillation was performed on the neat liquid unknown **after** the apparatus was assembled. The procedure can be found in Experimental Organic Chemistry (Wilcox & Wilcox) pg. 66.Binary Mixture: The fractional distillation of the unknown binary mixture was performed **after** the apparatus was assembled. The procedure for fractional distillation can be found on pages 66-67 (Wilcox & Wilcox). **After** the compounds had been separated and their boiling points found (Wilcox & Wilcox pg. 45), the series of tests and measurements had to be performed, which are as follows: (C_3100_SW)

Many of the student writing samples do not contain time adverbials at all, and they are just as infrequently found in the CRC. The lack of features that make up Dimension 4 combined with the lack of strongly negative or positive scores in the data, make it difficult to make meaningful interpretations of the findings.

6.5 Summary

In sum, the results of the multidimensional analysis conducted in this study show important differences between the disciplines of chemistry and psychology as well as between the registers of student writing and course readings. Overall, psychology uses features of academic involvement, contextualized narration, is human-focused and shows a slight propensity towards 'academese.' The course readings in psychology employ more features of academic involvement than student writing. Student writing tends to use features of contextualized narration in summaries, while narration is typically used to illustrate a point in the course readings.

Chemistry, as a discipline, demonstrated a use of linguistic features that were not heavily used in psychology, revealing the writing of each discipline as quite different from each other. Chemistry writing is informationally dense, favors language of procedural description over narration, and has a non-human focus. Chemistry textbooks tend to be more narrative than student writing as the textbooks use

language to directly address and engage the student reader. Chemistry student writing, on the other hand, is more concerned with presenting findings and therefore relies of features of informational density and procedural description. This is reflective of the different purposes of the two types of writing and will be described further in chapter 7.

7 UNDERGRADUATE WRITING IN PSYCHOLOGY AND CHEMISTRY: CONCLUSIONS AND IMPLICATIONS

The objective of this study has been to explore undergraduate disciplinary writing from a variety of perspectives. This study has explored undergraduate writing in psychology and chemistry following both qualitative and quantitative methods. The writing tasks assigned in undergraduate courses have been classified and analyzed, the expectations of instructors and the experiences of students have been explored through the analysis of qualitative interviews and the course readings and student writing have been analyzed for linguistic features using multidimensional analysis. Chapter 3 presents the methodology followed in order to answer each of the four research questions. The classification of the writing tasks assigned in psychology and chemistry is detailed in Chapter 4. The themes discovered in the faculty and student interviews are described in Chapter 5. Chapter 6 presents the results of the multidimensional analysis of linguistic variation between the course readings and student writing in psychology and chemistry. This final chapter concludes this study by summarizing the findings of this study in relation to the four research questions presented in the introduction and placing the findings among the reviewed literature. Next the limitations to the study are discussed followed by the implications of the results for teaching undergraduate disciplinary writing. The chapter concludes by exploring avenues for further research.

7.1 Writing assignments in psychology and chemistry

Research question one, exploring the amount and type of writing assigned to undergraduate students at each level of study in psychology and chemistry, was investigated primarily through the collection of course syllabi. Syllabi were collected from each of the focal courses used in the study (13 in psychology and 12 in chemistry, as described in chapter 3). Faculty responses to survey questions regarding the amount and importance of writing assignments, and interview questions asking faculty

about writing assignments were also part of the data collection. The assignments listed in the course syllabi were categorized according to the taxonomy developed by Horowitz (1986) (see chapter 3.3) which included seven categories listed in order of increasing length and complexity: *summary of / reaction to a reading, annotated bibliography, report on a specified participatory experience*, *connection of theory and data, case study, synthesis of multiple sources*, and *research project*.

At the lower division of undergraduate study in both chemistry and psychology students are not writing much at all. In fact, 75% of the lower division psychology courses in this study did not require writing. The upper division courses generally require at least one large writing assignment per course. In psychology, writing types vary depending on the purpose of the course. The most common writing assignment requires students to demonstrate critical thinking and an understanding of course content by connecting the theory learned in the course with an experience outside of class, for example, a newspaper article they've read, a film they've watched, or perhaps a person they've interviewed. Three of Horowitz's categories involve this type of cognitive task; *summary/reaction to a reading, connection of theory and data,* and *case study.* Taken together, these categories make up 82% of the psychology assignments in the focal courses. These assignments varied in their complexity and number. In psychology 2040, Introduction to Applied Psychology, for example, three 200-word summaries of a current event that represents an application of psychology are required, but these shorter assignments make up a small percentage of the course grade. Psychology 3110, Interpersonal Behavior and psychology 4020, Social Psychology, both have one longer assignment requiring students to watch a film and apply two course concepts to their analysis of the film. Though these longer assignments are just one part of the assessment in the course, they are weighted more heavily than the summaries required in psychology 2040. Psychology 3530 is the primary disciplinary writing course in the undergraduate program. The goal is to teach students to write a scholarly research proposal as well as to familiarize them with standard research practices in the discipline. The course focuses on building scientific literacy through the decon-

struction and analysis of different sections of published research articles. After analyzing the components of published articles, students begin writing research proposals section by section. It is in this course that most students are first exposed to professional writing for the field.

Chemistry demonstrated much less variety in assignment types, with nearly all writing fitting the category *report on a specified participatory experience*, essentially a laboratory report. Students are not doing much writing at the lower division. In chemistry 1151 and 1152, students are summarizing experimental procedures and writing expected outcomes. This pre-laboratory report is intended to prepare students for the writing they will be doing in their subsequent courses. Students begin writing laboratory reports in general chemistry. These reports are worth a very small percentage of their final grade, however. All writing in chemistry takes place in the practical courses, which are the laboratories. Like psychology, one purpose of the lab report is to connect theory and practice; to connect what students are learning in the lecture with what they are doing in the lab.

7.2 Writing expectations and experiences

Research question two contained two parts: instructors' expectations of student writing and students' experiences writing for their disciplines. The findings for writing expectations will be discussed first followed by the students' experiences.

7.2.1 Instructors' expectations of student writers

In depth interviews with faculty members provided the data for understanding faculty expectations of undergraduate writing in psychology and chemistry. The explanations of writing assignments examined in the course syllabi, along with rubrics and guidelines provided by the faculty also served to highlight faculty expectations of student writing. As detailed in chapter 3.5.1, four faculty members were interviewed in psychology and three were interviewed in chemistry. The interviews were read iteratively and coded for themes related to expectations.

According to the interviews, psychology instructors expect students coming into the major to have had some experience with general academic writing, though they find that this is not often the case. Because of the variety of assignment types in various courses and the heterogeneity of the students' experience, psychology instructors are prepared to give students detailed guidance for assignments in the form of handouts, rubrics, and in-class instruction. Most professors do not expect to teach students how to write, unless they are teaching psychology 3530. They expect students to demonstrate critical thinking in their writing at all levels.

Chemistry instructors also expect students to have a general understanding of writing from high school chemistry courses and freshman composition. Instructors do not expect to teach students how to write, but do expect to give guidelines and to spend time in the pre-laboratory lecture discussing each section of the required report, including style elements such as avoiding first person pronouns and writing in passive voice. Professors find that students have the most trouble with the discussion or conclusion section of the report, where they are expected to critically evaluate their experiment and essentially join the theory to practice.

7.2.2 Students' experiences learning to write for their discipline

The interviews conducted with students in psychology and chemistry explored the students' experiences learning to write for their discipline and their understanding of what their professors expected, and were used to answer the third part of research question one. Five students were interviewed in each discipline. A description of each of the interviewees is provided in chapter 3.5.2.

In general, students in psychology seem to feel that they reasonably understood what different instructors expected of their writing. This understanding, however, seems to be on an individual assignment and instructor-specific basis. In other words, students discussed having a clear understanding of a particular assignment in a specific class and often credited handouts, models, rubrics, or special instructions as making larger assignments clear. For smaller assignments, a 'good' grade was considered evi-

dence of understanding expectations. Students also spoke about thinking they understood the instructor's expectations and then being surprised by a lower than expected grade. In such cases, the students met with their instructors and felt the ensuing discussion clarified their misunderstandings. The students reported higher grades on subsequent assignments. The important point is that although many of the assignments in psychology are requiring similar tasks—summarizing, analyzing, and applying—students are not necessarily making the connection between the assignments. This may not be a deficit on the part of the students. It could be that although the assignments are ostensibly similar, the instructors' expectations are quite different from one another. The students interviewed specifically cited psychology 3530, advanced research design and analysis as how they learned to write for the discipline. Through that course, students learned to analyze and evaluate published journal articles and practice writing each section of a research proposal. Because students will not likely write a research proposal again as an undergraduate, they need to be able to generalize the skills they acquire in Psyc 3530 to other types of psychology writing. However, it is unclear how appropriately those skills transfer to other genres.

Students in chemistry seem to have the most difficulty connecting theory with application and many cite the discontinuity of instruction as part of the problem. Lectures and labs are taught by different instructors and in some cases, lecture classes are taught by several instructors throughout the semester. Students report that they often experience professor's expectations as idiosyncratic. While they are comfortable with the general format for writing a chemistry report, they do not always feel they clearly understand how each professor is grading their work. Students report that they feel they most clearly learned to write for chemistry when they began their laboratory research courses. The environment of the lab—the nature of the work and the mentor relationship-- foster students' development in the rhetorical mode of the discipline.

The interviews with students and faculty in both psychology and chemistry show a disconnect between the instructors' expectations of student writing and students' experiences learning to write for

their disciplines. In general, instructors find that students exhibit the most difficulty when it comes to understanding the writing sections that require critical thinking. In psychology this could be the reaction section or the discussion. In chemistry it is the discussion or conclusion section.

Students seem to find instructors' expectations somewhat idiosyncratic, finding that each professor expects something a bit different (chemistry) or that there is little to no correlation between similar seeming assignments (psychology). Though undergraduate faculty in both disciplines stated that they did not expect students to have an understanding of disciplinary writing coming into the program, they seem to expect that students will pick up on some of the conventions as they move through their program. Also, as pointed out by Dr. Spencer in her interview, whether they are aware of it or not, faculty are deeply steeped in the rhetorical mode of their discipline as this is where they have been reading, researching, and publishing for the length of their careers.

Despite the fact that instructors in chemistry and psychology are expecting students to engage in critical thinking through writing in nearly every writing assignment, students are not given explicit writing instruction until their first CTW course, usually their junior year. While the CTW courses are designed to give students extensive experience with writing for the discipline through the submission of multiple drafts, this course might be offered a too late in the program to truly benefit the students. Some may argue that the intensity of the CTW course requires the students to have a substantial foundation in the discipline, and that may be valid. Perhaps a more generalized writing course in critical thinking offered earlier in the program would help students make connections between assignments and help faculty standardize their expectations of the students.

7.3 Course readings in psychology and chemistry

The third research question explored in this study asks, *What types of writing are undergraduate students exposed to through their course readings throughout their academic careers in Psychology and*

Chemistry? Two methods of analysis in this study were used to find answers to this question. The first was based on the collection of course readings for the reading corpora. These texts were collected according to the required texts listed in the focal course syllabi. Looking at the texts types in the corpus gives an idea as to the types of materials students are reading. In psychology, students are primarily reading textbooks geared toward North American college students. In one course, Natural Science Aspects of Psychology (Psyc 1100), a general audience book is also required. Several courses require students to find and read magazine, newspaper, and published journal articles, but as the students are selecting these readings themselves, there is no way to ensure that all students are reading articles of a similar length or complexity, so including them in the corpus was not possible. In chemistry students are reading equal numbers of textbooks and laboratory manuals. Lab manuals have two purposes, to introduce an experiment, and to give procedural instructions for the experiment. Students also read some published articles, but again these are chosen by the students, or chosen for individual students by their lab mentors or professors.

The second method of analysis that helps answer this question is the linguistic analysis of the reading corpora (PRC and CRC). This was done through multidimensional analysis as described in Chapter 3. The reading corpora were analyzed according to the linguistic features that make up the four dimensions used in this study (academic involvement and elaboration vs. information density, contextualized narration vs. procedural description, human vs. non-human focus, and 'academese') (see Chapter 6). The results of the analysis show the texts in the PRC use features showing academic involvement such as first person plural pronouns and stance structures. The corpus also used features of contextualized narration, though the use of narrative comes in particular sections of the textbooks, usually the beginning of a new chapter or topic, and serves to involve the reader in the book. Sometimes elements of this story are carried through the chapter, though the more content heavy sections display more features of information density. The course readings show a definite human focus through the high use of

third person pronouns. On the whole, the PRC shows language that is academic in use, but also focused on engaging the reader. Table 7.1 lists the most distinguishing features found in each register by discipline.

Table 7.1 Characteristic linguistic features by register and discipline

	Psychology	Chemistry
Course reading	**Pronouns**: 1st & 3rd person, demonstrative **Verbs**: past tense, perfect aspect, mental, activity & communication	**Prepositions** **Nouns** **Verbs:** past tense passive
Student writing	**Adjectives**: evaluative **Pronouns:** 3rd person **Nouns**: group, animate **Verbs**: mental, activity & communication, past tense	**Nouns:** concrete, technical **Verbs:** past tense agentless passive, activity **Adjectives:** attributive **Prepositions**

The CRC corpus was consistently on the negative side for each dimension. Chemistry writing demonstrates a preference for informational density. The use of positive features, such as evaluative adjectives and demonstrative pronouns, though infrequent, indicates an attempt to address and involve the student reader. The CRC favors language of procedural description, though not as strongly as is found in student writing. The CRC has a non-human focus primarily indicated through the absence of pronouns. The writing is strongly focused on experimental procedures and chemical reactions and not typically on people. In sum, the course readings for chemistry tend to be informationally dense but with an awareness of the student audience. The texts use linguistic features of procedural description and focus on chemical processes and experimental procedures, rather than humans. The strength of each of these trends is mitigated by the moderate scores for each dimension, which supports the primary purpose of the texts—to initiate novices to the discipline. The moderate scores indicate an awareness of the audience and the audience's ability to digest informationally dense and highly procedural language.

7.4 Student writing in psychology and chemistry

The final research question of this study seeks a linguistic description of student writing in psychology and chemistry and an explanation of how student writing compares to the writing students were exposed to through their course readings. As with research question two, multidimensional analysis using the four dimensions Gray (2011) formulated for academic writing was used to answer this question (see chapters 3.7 and 4.5). This section will begin with a description of student writing in psychology, interposed by a comparison with the findings for the psychology course readings, after which the two registers for chemistry will be similarly addressed.

7.4.1 Psychology student writing

Student writing in psychology shows features of *academic involvement*. The most frequently used feature tends to be evaluative adjectives which are used to show the writer's stance. Considering that the majority of tasks assigned in psychology require students to summarize and respond critically to a source (e.g. newspaper article, or film), it is logical that students would use evaluative language. The nature of involvement, and consequently, the linguistic features used differs between student writing and the course readings. In student writing there are more references to the writer's stance and beliefs than there are references to the audience. There are, however, few if any direct references to the author shown by the lack of first person pronouns, a feature found in the course readings. Again, this is reflective of the assignment type. It is the student's responsibility to demonstrate an understanding and critical analysis of the subject sufficient to convince the audience (the instructor) that the student has satisfied their expectations. In the course readings, on the other hand, involvement is realized through the use of several features, including the use of first person pronouns (typically the plural "we"), though fewer evaluative adjectives tend to be used than in student writing. In this case, the involvement focuses on the audience rather than the author. There are few references to the author's beliefs or stance while the reader is sometimes directly referenced.

The PSWC demonstrated that student writing has more contextualized narration than procedural description. The most frequently used features are third person pronouns, group nouns, and animate nouns. Past tense verbs are also used, but appear less frequently than the nouns. These features tend to appear in the summary sections of texts, which 82% of the assignments in this study required. The course readings also contained a high number of nouns and pronouns, but used a much higher number of past tense and perfect aspect verbs than the student writing. While these features were found in the summaries in student writing, in the course readings the features were usually clustered within a story used to illustrate the larger topic of a textbook chapter.

Student writing in psychology, as with the course readings, has a human focus. This is realized primarily through the use of mental, activity, and communication verbs as well as *wh*-clauses. The PSWC and PRC used these features in similar proportions, though the PRC relies more heavily on pronoun use, while the PSWC tends to use very few pronouns.

In sum, though psychology student writing and course readings have similarities, particularly in their positive positioning on each of the four dimensions analyzed in this study, a closer look at how the features are used reveals important differences between the two registers. Psychology student writing tends to use fewer pronouns overall than the course readings. When pronouns are used, they are third person, or demonstrative and are used in specific contexts, such as summarizing and not to reference the writer. In fact, student writing tends to use evaluative language to show the writer's stance without directly referencing the writer. In summary writing, an important part of writing in psychology, students use more animate nouns, third person pronouns, and past tense verbs.

7.4.2 Chemistry student writing

Chemistry student writing consistently scored lower than the chemistry course readings on each of the four dimensions. Chemistry student writing uses linguistic features that convey information density. This is specifically realized through the heavy use of nouns and past tense passive voice construc-

tions. In comparison, the chemistry course readings use a wider variety of linguistic features that show information density, including a higher use of prepositions. The course readings are also less reliant on passive voice verbs and nouns and tend to use fewer features overall than does the student writing. The purpose of student writing tends to be more informational than the texts that make up the CRC. Chemistry students are encouraged to write as concisely as possible (Arnett, Easton, personal communication) which contributes to the density of the writing. In addition, the textbooks and laboratory manuals that make up the CRC have the purpose of explaining and describing concepts and procedures making the writing less dense, while the student writing is providing a procedural report of an experiment. Chemistry student writing also uses linguistic features of procedural description realized through the use of concrete and technical nouns. These noun types are heavily used in chemistry laboratory reports as a large part of chemistry report writing is procedural description.

Owing in large part to the nature of laboratory report writing in chemistry, the CSWC has a distinctly non-human focus. Linguistic features specifically contributing to the non-human focus are the frequent use of attributive adjectives and prepositions. These are also the most frequent features used in the CRC, though they are used to a lesser extent. Chemistry student writing frequently employs a large number of activity verbs, which usually indicate a human focus. In chemistry student writing, however, these verbs are used in agentless passive constructions usually in the procedural sections of laboratory reports. The chemistry course readings do not frequently use these verb types.

Overall, chemistry student writing frequently uses complex noun phrases with attributive adjectives, concrete or technical nouns and prepositional phrases. Verbs are usually used in past tense agentless passive constructions and are often activity verbs. All of these linguistic features occur more frequently in student writing than in the course readings.

7.5 Summary of results

To summarize, the three parts of this study present a rather full picture of disciplinary writing at the undergraduate level in psychology and chemistry from very different perspectives. The first approach looked at the writing assignments given at each level of study and categorized them according to the taxonomy Horowitz (1986) developed for undergraduate writing prompts. The second approach focused on the expectations of instructors and the experiences of students with regard to writing in psychology and chemistry explored through interviews with faculty and students in each discipline. The final approach used Multidimensional analysis to give a linguistic description of the writing students are exposed to through their course readings as well as the writing that students produce.

The first major result of the three aspects of this study is that the two disciplines explored are vastly different from each other particularly with regard to undergraduate writing. Psychology courses assign a variety of writing tasks that also vary in length, complexity, quantity, and grade weight. Writing in chemistry tends to be more homogenous in type, length, and to some extent, grade weight. Complexity and quantity tend to have an inverse relationship depending on the course number; as the course number increases the complexity of the experiments increase and consequently, the complexity of the writing also increases. The number of reports required, however, usually decreases. Psychology instructors expect students to be able to write in a general academic register (though this only specifically described as having acceptable grammar, complete sentences, and organization around a central point) and to be able to learn to write in APA style throughout the program and specifically through Psyc 3530, Advanced Research Design and Statistics. Chemistry instructors expect students to have some idea of how to write a laboratory report. They expect students to also use correct grammar and complete sentences as well as to avoid personal pronouns, use passive voice, and write concisely. Instructors expect the students to incorporate the latter three features in their writing just by writing this warning in the syllabus and repeating it during class. Finally, the writing, both student writing and course readings, in

each discipline are also very different from each other. Both registers show features of academic involvement in psychology, while they show information density in chemistry. Psychology writing relies more on contextualized narration, where chemistry prefers procedural description. Psychology has a human focus and chemistry a non-human focus and psychology uses slightly more features of 'academese' than chemistry, possibly a case of psychology more overtly establishing its empirical research paradigm.

The second result is that students in psychology and chemistry the writing demands tend to be low until the 3000 level and that writing expectations can vary widely between professors even for similar assignments. In psychology, many writing prompts require students to apply knowledge from the course to an outside source by summarizing the source and providing a critical analysis. The expectations, including the length and the grade weight of these assignments varies greatly from instructor to instructor. Oftentimes, individual instructors will provide various forms of support to help clarify expectations, but these are often so assignment specific, that students have difficulty effectively generalizing between similar assignments in different courses. In chemistry, though the writing type is basically the same in all courses, students find that different professors expect very different reports. Unfortunately, because of the assumed similitude, these differences are often relayed to the student through an unsatisfactory evaluation. Instructors also tend to assume that students come into the program with some understanding of how to write a basic laboratory report and though most students might have written such reports in high school, the expectations are understandably more stringent in college.

The third result of this study is that student writing in psychology and chemistry is linguistically quite different from the disciplinary writing students are exposed to through their course readings. For the most part, these differences are reflective of the differences in purpose and audience for each register. However, as students are not getting explicit writing instruction in their disciplines until the 3000 or 4000 level (typically their junior year), the course readings may serve as the primary source of written

disciplinary discourse for students. Perhaps supplementing the readings with writing that is more linguistically similar to the writing they are expected to produce would be helpful.

7.6 Placing the present study in the framework of reviewed literature

The studies reviewed in Chapter 2 were addressed in five categories: studies that addressed academic writing and the diversity of writing in the disciplines, studies classifying disciplinary writing tasks, studies exploring writing expectations and students' experiences, studies on the connection of reading and writing tasks, and studies using multidimensional analysis. The following subsections focus on each of these categories.

7.6.1 Studies of academic writing and the diversity of disciplinary writing

The studies reviewed in Chapter 2 demonstrate that *academic writing* is a complex term that has been difficult to define. In fact, studies treating *academic writing* as a single entity (Chafe, 1986; Chafe & Danielewicz, 1987) have been problematized by Hyland (2000, 2009), in particular. A perhaps more useful or productive view of academic writing has been to recognize it as a dynamic and highly contexualized communication act that cannot be removed from the context in which it takes place (Berkenkotter & Huckin, 1995; Bhatia, 2004; Gee, 1996). The disciplines have been a popular context for the study of linguistic diversity in academic writing with studies exploring the differences in writing in the disciplines from a genre perspective (e.g. Bhatia, 2004; Swales, 2004)or some using a quantitative corpus-based approach (e.g. Biber, 2006). While studies, particularly those coming from a composition and rhetoric perspective have argued that academic writing is too particular to specific disciplines for there to be any value in attempting to teach a generalized version of it (Elbow, 1991; Macrorie, 1980) while others, especially those concerned with second language writing, have looked for commonalities across disciplines that might be used to benefit students (e.g. Belcher, 1995; Johns, 2008).

The present study builds on the knowledge of writing in the disciplines established by the reviewed studies. In terms of looking at disciplinary writing, the major aim of this study was to explore writing in two diverse undergraduate disciplines, psychology and chemistry, to better understand both their similarities and differences and determine how best to prepare students for the writing they will encounter as undergraduates in their majors. The results show that there are similarities as suggested by Belcher(1995) and Johns (2008), but these similarities tend to extend across assignments within a discipline or are perhaps generalizable to larger disciplinary areas if the findings of Carstens (2008) and Jackson et al. (2006)are considered. Perhaps more importantly with regard to disciplinary writing, this study demonstrates that students have difficulty making connections between similar writing tasks that are named differently and tend to overgeneralize writing tasks bearing the same title. The former was found in psychology, where writing tasks in different courses were often similar, but bore different names, while the latter was found in chemistry where the majority of writing assignments are called lab reports.

7.6.2 Studies classifying disciplinary writing tasks

Many of the studies discussed in Chapter 2 for the present study borrow the writing classification taxonomy developed by Horowitz (1986) for his study of writing tasks across a diversity of disciplines in order to understand what professors require of students (Braine, 1989; Hale et al., 1996; Zhu, 2004). Other studies of writing assignments have formulated their own categories (Canseco & Byrd, 1989; Carstens, 2008; Cooper & Bikowski, 2007), but due to different nomenclature, it is difficult to determine how much overlap exists between these categories and those used by Horowitz (1986). In addition, perhaps because these categories in these studies were predicated on a specific set of data, they have not been used in subsequent studies. This makes comparisons between studies difficult and also makes it difficult to determine the rigor of these taxonomies. The present study adopts Horowitz's classification scheme because the study is based on similar data, albeit a smaller sample. This taxonomy has

proven useful in other studies of undergraduate writing assignments and allowed comparisons across studies. The present study helps strengthen Horowitz's (1986) taxonomy by applying it to a new set of assignments, for which the classification scheme proved both useful and accurate.

7.6.3 Studies exploring writing expectations and students' experiences

Studies examining instructors' expectations of student writers have primarily been conducted in the area of WID (writing in the disciplines) and have demonstrated that instructors are often unaware of the degree to which their expectations of undergraduate writing are related to the discursive practices of their disciplines (e.g. Thaiss & Zawacki, 2006; Wilder, 2012). Professors tend to discuss their expectations of undergraduate writing in terms of generic standards for academic writing and avoid discipline-specific language (Thaiss & Zawacki, 2006). In fact, one study found that professors seek to avoid giving assignments they feel mimic professional genres, preferring assignments that help students connect with the content (Schmersahl & Stay, 1992). This desire to avoid assignments that seem too discipline-specific, coupled with a lack of awareness of the discipline orientation of expectations can lead to expectations that are confusing for students to decode. The present study considered the findings of instructors' expectations and assignments in the light of this previous research to provide a more robust interpretation of the themes discovered in the interviews with faculty.

The studies on students' experiences as writers reviewed in chapter 2 were predominantly based on case studies of single students (McCarthy, 1987) or groups of students (Carroll, 2002; Leki, 2007). These studies demonstrated that learning to write for a discipline, or to meet disciplinary instructors' expectations, is a complex literacy task that develops slowly over time. McCarthy (1987) also demonstrated the difficulty students have determining expectations of writing across disciplines. Students may also have a difficulty finding commonalities in assignments across disciplines. The present study expands the area of expectations through the discovery of themes that summarized and encompassed faculty and students' concerns and revealed a mismatch between these two groups.

7.6.4 Studies on the connection of reading and writing tasks

Much of the research reviewed in Chapter 2 has centered on the importance of reading tasks on writing and the inter-relatedness of reading and writing to developing literacy (Ackerman, 1991; Bazerman, 1980; Carson et al., 1992; Haas & Flower, 1988). The present study acknowledges the relationship between reading and writing as demonstrated by previous research and aimed to look more closely at reading as a source of disciplinary discourse knowledge which might serve as a model of disciplinary writing. This relationship between course readings and writing was explored by Jackson, Meyer, and Parkinson (2006) in their study of reading and writing in science disciplines. Their findings, that course readings in science have very little in common with the genre of writing students are producing, were influential on the present study. The present study also demonstrated a lack of connection between the course readings and the writing tasks students are expected to complete. In chemistry the findings of the present study are similar to those of Jackson et al. (2006). The undergraduate writing tasks in chemistry are similar in genre to published writing in the discipline, yet students read very little professional writing. This study extends previous work by also looking at psychology, which revealed different results. For psychology the relationship between course readings and student writing is less transparent. At times course readings provide some of the content knowledge for writing tasks. The majority of writing tasks in psychology, however, are not very similar in genre to professional psychology writing.

7.6.5 Studies using multidimensional analysis to study linguistic variation in disciplinary writing

The studies reviewed in Chapter 2 have used multidimensional analysis to study register variation in the disciplines in two ways. One type of study seeks to broaden the understanding of linguistic variation of registers by applying the seven Dimensions of register variation established by Biber (1988) to new registers (e.g. Conrad, 1996; Helt, 2001). These studies then use Biber's (1988) findings as a point of comparison for their own findings. Studies based on Biber's seven Dimensions of variation across reg-

isters have demonstrated the robustness of using multidimensional analysis in studies of language variation. A second approach is to formulate new Dimensions based on a factor analysis of linguistic features in a corpus of a particular register. These linguistic features are then plotted on the newly formed Dimensions, to reveal how texts of a particular register cluster together based on the use of certain linguistic features. Studies using this approach, such as Reppen (2001), Friginal (2009) and Gray (2011) typically explore registers that are outside the scope of the focus of Biber's (1988) Dimensions. The present study employed the four Dimensions of variation of academic writing developed by Gray (2011). Her study, as described in chapters 2 and 3, explored the linguistic variation in a corpus of journal articles across six disciplines. This study provided an appropriate framework for the present analysis of academic writing in psychology and chemistry and shows that using previously established dimensions is a reliable solution for analyzing small corpora using this type of statistical and analytical procedure.

7.7 Limitations of the present study

There are several limitations to consider that affect the generalizability of this study. The first limitation is that this study is essentially a case study of two departments at one university. The extent to which the results of this study are idiosyncratic to the setting in which the study took place is unclear. The results could be influenced by the culture and practices of the university and certainly of the departments themselves. The large size of the university and each department, particularly the psychology department could have an effect on the role writing plays in each program. The expectations of the professors in psychology and chemistry are likely shaped by the policies and practices of the department. While these factors are indeed limitations, the narrowness of this investigation was the cost of being able to explore each discipline from multiple perspectives.

A further possible limitation of the study is the choice of Horowitz (1986) as a classifying taxonomy. Horowitz's study is dated at present and more recent studies have been conducted on much larger sets of data with more complex taxonomies such as Melzer (2009). Horowitz's was chosen for this study

because his dataset and taxonomy most closely matched my research question regarding assignment classification. In the future, it might be interesting to consider an approach such as Melzer (2009) to explore the relationship between the writer, the assignment, and the audience in the writing assignments that comprise the data-set for the present study.

A second limitation is that the chemistry student writing corpus was much smaller at 34 texts than the psychology student writing corpus, which contained 57 texts. Having corpora of very different sizes can make comparisons between the corpora inaccurate. Moreover, if a corpus is too small, the results can be difficult to substantiate. In this case the difference in corpus size was not problematic because as part of the multidimensional analysis the corpora were standardized with Z scores. The small corpus size can, however, make finding examples to illustrate the use of specific features more challenging.

The third limitation of this study involves the student interview participants. The student sample interviewed is not likely representative of the undergraduate student population in each department. The students willing to volunteer their time to help my research expressed an awareness of the importance and difficulty of conducting academic research and a desire to help. This was particularly true of the psychology students, many of whom had participated in research within their department. The majority of the chemistry students had been officially recognized by the department for outstanding achievement in their field. Each is planning to continue studying at the post-graduate level. The students all self-identified as successful writers. Having high-achieving students proved to be advantageous for the interview process. The students demonstrated the self-awareness and metacognitive awareness necessary to critically reflect on their own learning process. However, as the writing of these particular students was not specifically tracked (though each contributed writing samples) the accuracy of their claims was not triangulated through analysis.

7.8 Implications for teaching disciplinary writing

There are three major implications of the present study for teaching disciplinary writing at the undergraduate level. The first implication comes from the differences found between psychology and chemistry, the two disciplines investigated in this study. The second and third implications come from the findings of this study within the disciplines of psychology and chemistry.

Psychology and chemistry have different research paradigms and these differences are realized in the way research is written up. As discussed in chapter 5, psychology and chemistry have different approaches to and expectations of undergraduate writing. Such differences might be reasonably extrapolated to include other disciplines in the social sciences versus physical sciences. Previous research on disciplinary writing (e.g.,Conrad, 1996; Gray, 2011; Hyland, 2000; Swales, 1990)has shown important differences in academic writing in different fields and it follows that these disciplinary differences would also be present in the writing expectations and assignments at the undergraduate level. In this study, instructors in both chemistry and psychology expected students to have basic academic writing skills (though this was not clearly defined) which the instructors assumed students had acquired in high school and through their freshman composition courses. Writing in high school and freshman composition is not usually oriented to any particular discipline. Students whose experience with academic writing includes writing expository, argumentative, or reflective essays, or generic library research papers (typical assignments in high school and freshman composition courses) might have a difficult time meeting even the basic expectations of professors in disciplines like psychology and chemistry. Perhaps a discipline-focused writing course offered during the first year of study would help to expose students to the writing style and expectations of their majors. Since many students delay declaring a major until their sophomore year, writing courses could be offered for disciplinary areas rather than for specific majors as each major already has a critical thinking through writing course that students take later in their course of study.

The second implication of this study is that students would benefit from both more opportunities to write in their disciplines as well as explicit writing instruction with more uniform expectations for the types of writing assigned. The results of this study show that in psychology, students do not consistently begin writing until the 3000 level. When they do begin writing, the majority of writing tasks assigned require the same skills, namely summary and critical response. The expectations for these assignments, however, vary from instructor to instructor. The critical thinking aspect of these writing assignments is where instructors indicate the students are particularly lacking in skill. In disciplines like psychology, teaching students how to summarize a source and demonstrate critical thinking through their response early in their academic careers might benefit them throughout the program. It also seems that instructors in psychology are unaware of both the similarity in writing tasks across courses and the lack of consensus in what is expected from similar assignments in different courses. Creating flexible standards for similar writing tasks that are agreed upon by all instructors might help students be more successful by giving them a clearer idea of expectations and more opportunities to practice their skills. In chemistry, all writing is in the form of laboratory reports which involve the same basic sections with slight variations. Students begin writing full laboratory reports in chemistry1211 and 1212, though only one report is required. Although the basic writing task is the same across courses, the expectations vary greatly from instructor to instructor. Instructors at the lower levels usually inform students, both verbally and in writing, that they should write with concision, avoiding personal pronouns and using passive voice, but that students are told to write this way, does not mean they understand how to write this way. Instructors find the discussion sections of laboratory reports to be the site where student writing is least satisfactory as students are not writing enough and not engaging in a critical analysis of their work. To this end, students (and instructors) would probably benefit from explicit instruction on the structure and expectations of laboratory report writing, with a focus on critical thinking, early in their program. As

with psychology, standardizing expectations across sections and courses might help students develop an understanding of disciplinary writing more easily.

The third implication of this study comes from the disciplinary writing students are exposed to throughout their undergraduate program. In both psychology and chemistry the students interviewed for the present study cited reading professional writing as an important source for learning to write in the style of the discipline. As shown by the course readings collected for this study, however, students are not reading professional writing very frequently. In psychology, students are encouraged or sometimes required to find journal articles as the basis for some writing assignments. In Psyc 3530, Advanced Research Design & Analysis, the first CTW course, students do read and dissect published psychology research articles for the purpose of understanding how research is reported in psychology. The vast majority of disciplinary writing that undergraduates read is in the form of textbooks. This study shows that textbook writing in psychology is linguistically very different from student writing. The situation is very similar in chemistry. Students are not required to read published reports outside of one or two advanced courses though both students and professors felt reading such articles was the most effective way of improving writing. Students usually read published writing as part of their research laboratory course, under the advisement of a lab mentor and lead professor. Again as with psychology, the primary sources of disciplinary writing input for students in chemistry are textbooks and laboratory manuals, which are very different from the student written laboratory reports. Since students are not given explicit writing instruction early in their program in psychology or chemistry and the primary source of disciplinary writing they are exposed to is textbooks, it is understandable that students would have some difficulty interpreting the discipline-specific writing expectations set by their instructors. It seems students would benefit from having a portion of course readings that are more reflective of the disciplinary style of writing they should be learning. Even reading parts of published reports could be quite helpful. For example, in psychology courses requiring summaries, the literature review sections of journal arti-

cles could be assigned as readings. In chemistry, students might benefit from reading the discussion sections of published reports. These readings could also be used quite effectively in discipline oriented freshman writing courses.

A final, but important implication of this study is for teaching academic writing to matriculated or university bound English language learners. This study shows that undergraduate writing is reflective of the rhetorical style of the discipline in which it occurs. English language learners attending or planning to attend a US university would benefit from writing instruction that considers the students' intended major. Understanding what students will be writing in their majors, how often, and when can help writing teachers prioritize instruction to be of maximum benefit to the students. Based on the findings of the present study, even in a general (meaning not discipline-oriented) preparatory writing class there are skills that are likely to be useful in a variety of majors. The first is summarizing. This skill is required by a large number of psychology writing tasks and is a major component of laboratory report writing in chemistry. The second skill is critical thinking. This is the most cognitively demanding part of writing and seems to be a part of nearly every assignment in both psychology and chemistry. Considering the university wide critical thinking through writing initiative at the university where this study took place, it is likely that critical thinking is a part of writing in most majors at most universities. This is also the area that instructors cite as the most problematic for students. Critical thinking is culturally valued in the US in ways that it may not be in other countries, making this an essential skill for English language learners to understand and master (Althen & Bennett, 2011). Finally, students need to learn to decode writing prompts to clearly understand the task. Oftentimes, writing assignments require similar skills such as summarizing and critical analysis, but because the prompts are worded very differently, students may not realize what they need to do to fulfill the instructor's expectations.

7.9 Avenues for further research

The present study is an exploratory step to more fully understanding undergraduate writing in the disciplines. There are many avenues to build from this study. One is to continue researching undergraduate writing within other popular majors to determine whether there are truly generalizeable writing skills across disciplines. Another vein of research would be into the creation of discipline oriented writing courses. Further research is needed to determine how to best group majors for the maximum benefit of the students. In terms of preparatory writing courses for English language learners longitudinal research is needed to see if teaching skills like summarizing, critical thinking and decoding writing prompts is actually effective once students enter their majors or whether a more discipline-specific approach necessary.

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APPENDICES

Appendix A: Consent forms

Georgia State University
Department of Applied Linguistics & ESL
Informed Consent

Title: Undergraduate Writing in Two Disciplines: Chemistry & Psychology

Principal Investigators: Kate Moran, Dr. Viviana Cortes

I. Purpose:

You are invited to take part in a research study. The purpose of the study is to examine the types of writing that undergraduate students do in Chemistry and Psychology classes. I am particularly interested in understanding faculty expectations of student writers in their classes. Being in the study will take about 1 hour of your time.

II. Procedures:

If you decide to take part, I will interview you one time during the semester. You will be interviewed about the types of writing tasks you assign in the undergraduate courses you teach, as well as your expectations of students as writers in the discipline. The interview will last between 30 and 60 minutes and occur at a place that you will choose. The interview will occur at times and on days that you choose. The interview will be recorded using an audio (sound only) recorder.

III. Risks:

In this study, you will not have any more risks than you would in a normal day of life.

IV. Benefits:

V. Voluntary Participation and Withdrawal:

Taking part in this research is your choice. You do not have to be in this study. If you decide to be in the study and change your mind, you have the right to drop out at any time. You may skip interview questions and stop being in the study at any time. Whatever you decide, you will not lose any benefits to which you are otherwise entitled.

VI. Confidentiality:

We will keep your records private to the extent allowed by law. Viviana Cortes (the supervising researcher) and I will have access to the information you provide. Information may also be shared with those who make sure the study is done correctly (GSU Institutional Review Board, the Office for Human Research Protection (OHRP)). All recordings of interviews will be moved to compact discs. These discs and your consent forms will be stored in a locked cabinet in the office of Viviana Cortes, my supervising researcher. The data will be kept after the study for future research purposes only. Even after the study ends, we will still keep the data private. We will use a name different from your own name on study records. The code sheet with the research participants' names will be stored in a locked cabinet in my home office. We will destroy the code sheet as soon as all of the data has been collected and recorded. Only my supervisor, Viviana Cortes, and I will have access to the information you give me. Your name and other facts that might reveal who you are will not appear when we present this study or publish its results.

VII. Contact Persons:

Call or email me if you have any questions or concerns regarding your participation in this study: Kate Moran 404-484-6858 eslkamx@langate.gsu.edu. If you have questions or concerns about your rights as a participant in this research study, you may contact Susan Vogtner in the Office of Research Integrity at 404-413-3513 or svogtner1@gsu.edu.

VIII. Copy of Consent Form to Subject:

We will give you a copy of this consent form to keep.

If you are willing to take part in this research and be recorded, please sign below.

_____ _____

Participant Date

_____ _____

Principal Investigator Researcher Obtaining Consent Date

Georgia State University
Department of Applied Linguistics & ESL
Informed Consent

Title: Undergraduate Writing in Two Disciplines: Chemistry & Psychology

Principal Investigators: Kate Moran, Dr. Viviana Cortes

I. Purpose:

You are invited to take part in a research study. The purpose of the study is to examine the types of writing that undergraduate students do in Chemistry and Psychology classes. I am particularly interested in understanding students' perceptions of writing tasks and assignments in their classes. Being in the study will take about 2 hours of your time.

II. Procedures:

If you decide to take part, I will interview you one time during the semester. You will be interviewed about the types of writing tasks assigned in either your chemistry or psychology classes or how you understand them as well as how you feel you learned to write in a manner that fulfills the task assignments. The interview will last between 30 and 60 minutes and occur at a place that you will choose. The interviews will occur at a time and day that you choose. The interview will be recorded using an audio (sound only) recorder.

III. Risks:

In this study, you will not have any more risks than you would in a normal day of life.

IV. Benefits:

You will have the opportunity to explore and verbalize your experiences and challenges with writing for your university classes.

V. Voluntary Participation and Withdrawal:

Taking part in this research is your choice. You do not have to be in this study. If you decide to be in the study and change your mind, you have the right to drop out at any time. You may skip interview questions and stop being in the study at any time. Whatever you decide, you will not lose any benefits to which you are otherwise entitled.

VI. Confidentiality:

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and your consent forms will be stored in a locked cabinet in the office of Viviana Cortes, my supervising researcher. The data will be kept after the study for future research purposes only. Even after the study ends, we will still keep the data private. We will use a name different from your own name on study records. The code sheet with the research participants' names will be stored in a locked cabinet in my home office. We will destroy the code sheet as soon as all of the data has been collected and recorded. Only my supervisor, Viviana Cortes, and I will have access to the information you give me. Your name and other facts that might reveal who you are will not appear when we present this study or publish its results.

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VIII. Copy of Consent Form to Subject:

We will give you a copy of this consent form to keep.

If you are willing to take part in this research and be recorded, please sign below.

_____ _____
Participant Date

_____ _____
Principal Investigator Researcher Obtaining Consent Date

Georgia State University
Department of Applied Linguistics & ESL
Informed Consent

Title: Undergraduate Writing in Two Disciplines: Chemistry & Psychology

Principal Investigators: Kate Moran, Dr. Viviana Cortes

I. Purpose:

This project is aimed at investigating the language used in upper-division undergraduate writing in chemistry and psychology, to look at the linguistic features of student writing and make comparisons with disciplinary readings both within and across disciplines.

II. Procedures:

If you decide to take part in this study, no extra work will be required of you. We will make a copy of your writing assignments after you have turned them in to your instructor. After copying the assignments, we will scan them into a computer along with all the other assignments we have collected. we will then use a computer program to analyze the features of writing in chemistry and psychology.

III. Risks:

In this study, you will not have any more risks than you would in a normal day of life.

IV. Benefits:

This study will provide more information about what undergraduate writing is like in two different disciplines. Right now, we don't know much about how students learn to write in a discipline or how to best teach writing. This study is an important step to understanding more about undergraduate writing.

V. Voluntary Participation and Withdrawal:

Taking part in this research is your choice. You do not have to be in this study. If you decide to be in the study and change your mind, you have the right to drop out at any time. Whatever you decide, you will not lose any benefits to which you are otherwise entitled.

VI. Confidentiality:

Your name will be removed from all writing samples we collect. There will be no record kept of your name. The data will be kept after the study for future research purposes only. Even after the study ends, we will still keep the data private. Your name and other facts that might reveal who you are will not appear when we present this study or publish its results.

VII. Contact Persons:

Call or email me if you have any questions or concerns regarding your participation in this study: Kate Moran 404-484-6858 eslkamx@langate.gsu.edu. If you have questions or concerns about your rights as a participant in this research study, you may contact Susan Vogtner in the Office of Research Integrity at 404-413-3513 or svogtner1@gsu.edu.

VIII. Copy of Consent Form to Subject:

We will give you a copy of this consent form to keep.

If you agree to participate in this project and have your writing assignments copied after you have handed them in to your instructor, please sign and date this form below.

_____ _____
Participant Date

_____ _____
Principal Investigator Researcher Obtaining Consent Date

Georgia State University
Department of Applied Linguistics & ESL
Informed Consent

Title: Undergraduate Writing in Chemistry & Psychology

Principal Investigators: Kate Moran, Dr. Viviana Cortes

I. Purpose:

You are invited to take part in a research study. The purpose of the study is to examine the types of writing that undergraduate students do in Chemistry and Psychology classes. I am particularly interested in understanding student experiences and challenges with the writing expectations in courses in chemistry and psychology. Completing this survey will take about 10 minutes of your time.

II. Procedures:

If you decide to take part, continue to the survey and complete the questionnaire.

III. Risks:

In this study, you will not have any more risks than you would in a normal day of life.

IV. Benefits:

This survey may not benefit you personally, but the results will give us more information about student experiences and challenges as undergraduate writers in chemistry and psychology.

V. Voluntary Participation and Withdrawal:

Taking part in this research is your choice. You do not have to be in this study. If you decide to be in the study and change your mind, you have the right to drop out at any time. Whatever you decide, you will not lose any benefits to which you are otherwise entitled.

VI. Confidentiality:

We will keep your records private as allowed by law. Viviana Cortes (the supervising researcher) and I will have access to the information you provide. Information may also be shared with those who make sure the study is done correctly (the GSU Institutional Review Board, the Office for Human Research Protection (OHRP)). The data will be kept after the study for future research purposes only. Even after the study ends, we will still keep the data private. Your name and other facts that might reveal who you are will not appear when we present this study or publish its results.

VII. Contact Persons:

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By continuing to the next page you are consenting to participate in this survey. If you do not wish to participate, do not continue to the next page.

Georgia State University
Department of Applied Linguistics & ESL
Informed Consent

Title: Undergraduate Writing in Chemistry & Psychology

Principal Investigators: Kate Moran, Dr. Viviana Cortes

I. Purpose:

You are invited to take part in a research study. The purpose of the study is to examine the types of writing that undergraduate students do in Chemistry and Psychology classes. I am particularly interested in understanding faculty expectations of student writers in their classes. Completing this survey will take about 10 minutes of your time.

II. Procedures:

If you decide to take part, continue to through the screens of the survey and complete the questionnaire.

III. Risks:

In this study, you will not have any more risks than you would in a normal day of life.

IV. Benefits:

This survey may not benefit you personally, but the results will give us more information about faculty expectations and requirements of undergraduate writers in chemistry and psychology.

V. Voluntary Participation and Withdrawal:

Taking part in this research is your choice. You do not have to be in this study. If you decide to be in the study and change your mind, you have the right to drop out at any time. Whatever you decide, you will not lose any benefits to which you are otherwise entitled.

VI. Confidentiality:

We will keep your records private as allowed by law. Viviana Cortes (the supervising researcher) and I will have access to the information you provide. Information may also be shared with those who make sure the study is done correctly (the GSU Institutional Review Board, the Office for Human Research Protection (OHRP)). The data will be kept after the study for future research purposes only. Even after the study ends, we will still keep the data private. Your name and other facts that might reveal who you are will not appear when we present this study or publish its results.

VII. Contact Persons:

Call or email me if you have any questions or concerns regarding your participation in this study: Kate Moran 404-484-6858 eslkamx@langate.gsu.edu. If you have questions or concerns about your rights as a participant in this research study, you may contact Susan Vogtner in the Office of Research Integrity at 404-413-3513 or svogtner1@gsu.edu.

By continuing to the next page you are consenting to participate in this survey. If you do not wish to participate, do not continue to the next page.

Appendix B: Interview protocols

Student Interview

Background information

Name:

Age:

Year in program:

Major: Chemistry or Psychology

What made you choose chemistry/psychology as your major?

I'm interested in understanding how students in psychology/ chemistry learn to write in ways that are appropriate for that discipline.

Writing tasks

Think back to the start of your studies. How many writing assignments would you estimate you had per class in your major?

What kinds of writing tasks did you complete? Include any writing you remember, even if it was on tests.

Do you feel like you were assigned more significant writing tasks as you progressed in your degree program?

Can you describe a writing assignment you found challenging?

Instructor expectations

What specific classes have required the most writing in your major?

For classes that required more writing, did you feel you understood what the instructor was expecting?

How did you understand their expectations?

Did you feel prepared to meet those expectations?

How do you typically get assignments for writing tasks? (in syllabus, as a separate handout)

Think about a grade you received on a specific writing assignment in a class in your major. In your opinion, how do you think your professors arrived at your grade on major writing assignments?

Did you know before you completed the assignment how the assignment would be graded?

Do instructors in your major classes typically give specific instructions for writing assignments?

Do instructors typically provide models, or guides?

Do they usually spend time in class discussing the details of writing assignments?

Outside of the CTW courses, do instructors typically allow you to submit drafts of assignments?

Learning to write for the major

How do you feel you learned to write for psychology/chemistry?

Do you feel you learned to write in a particular course, where the professor gave explicit instruction, or do you feel like you figured it out along the way?

Was learning to write appropriately for psychology/chemistry a challenging process?

If you had to give advice to a new psychology/chemistry major, with regard to learning to write successfully for their psychology/ chemistry classes, what would it be?

Faculty interview

Background information

Name:

Department:

Position:

How long have you been a professor at GSU?

Which undergraduate courses do you typically teach?

For this study, I'm particularly interested in learning more about the writing students are doing throughout the program, what instructors' expect of student writing, and what the overall writing goals are for a student who successfully completes the program.

Writing tasks

What types of writing tasks do you frequently assign in undergraduate courses?

Why do you assign these tasks?

Do any of the courses you teach have a large percentage of the grade based on writing assignments?

Writing expectations

In your classes, what do you expect from students as writers? You can talk about how those expectations might change based on course level.

Do you expect students will begin their major course work with some knowledge and facility with academic writing?

Do you expect them to know how to write for psychology/chemistry when they begin their major course work?

Do you expect to teach students how to write for psychology/chemistry?

(if yes) How do you teach writing?

Do you expect students to follow APA/ACS guidelines in the courses you teach?

How do you inform students of your expectations for their writing?

What criteria do you use when evaluating student writing?

Do the students know these criteria in advance?

What is the departmental goal for the writing ability of students who graduate from the program?

How do think students learn to write in a way that meets instructor as well as departmental expectations?

Reading and writing

What types of reading do students do in your courses?

Do you think this reading has an effect on their writing for the discipline?

Do students read typically read professional writing in their undergraduate courses?

Do you think it is important for students to read professional writing?

Appendix C: Survey instruments

Student Survey

You are invited to take part in a research study. The purpose of the study is to examine the types of writing that undergraduate students do in Chemistry and Psychology classes. I am particularly interested in understanding student experiences and challenges with the writing expectations in courses in chemistry and psychology. Completing this survey will take about 10 minutes of your time.

Demographic information

Name:

Major :

Year in degree program:

Name of this course:

Reading

1. How reading intensive do you consider this course compared to other courses you are taking this semester?

4. Very much so 3. Somewhat 2. Not very 1. Not at all

2. How necessary do you feel careful reading is to your success in this course?

4. Very much so 3. Somewhat 2. Not very 1. Not at all

3. How much time you do spend reading per class meeting for this course?

a) more than 4 hours
b) 2-4 hours
c) 1-2 hours
d) less than 1 hour

5. What seems to be the purposes of course readings? (check all that apply)

- serve as foundation for the course
- help you study for tests
- Supplement the instructor's lectures
- Help you become more familiar with the discipline
- To give you multiple perspectives on the discipline
- other (please comment)

5. What kinds of materials do read for this class? (check all that apply)

- Text books
- Journal articles
- Primary sources
- handouts
- case studies
- newspaper/magazine articles
- surveys
- professional reports
- other (please comment)

Writing

6. How writing intensive do you consider this course compared to other courses you are taking this semester?

4. Very much so 3. Somewhat 2. Not very 1. Not at all

7. Do you feel you have to be a good writer to pass this course?

4. Very much so 3. Somewhat 2. Not very 1. Not at all

8. Does your instructor teach you how to write effectively as part of this course?

4. Very much so 3. Somewhat 2. Not very 1. Not at all

10. What seems to be the purposes of writing assignments in this class? (check all that apply)

- demonstrate understanding of the content
- learn to become a better writer in the discipline
- other (please comment)

11. What kinds of writing tasks are you required to do for this class? (check all that apply)

- Reflections/journals
- Reaction papers
- Reports
- Research papers
- compositions/essays

- other (please comment)

12. What kinds of writing do students do on tests? (check all that apply)

- Short answers
- Essays
- Bulleted lists or outlined answers
- Multiple choice
- Other (please comment)

13. What do you feel the instructor evaluates in your writing assignments? (check all that apply)

- content
- language use
- structure/format
- other (please comment)

Faculty survey

The purpose of this survey to better understand your expectations of undergraduate students regarding writing and reading in the courses you typically teach. Please answer the questions in accordance with a course that you frequently teach. You should be able to complete the survey within ten minutes.

Demographic information

Name:

Department:

Position:

Courses you typically teach:

Course you are considering for the purpose of this survey:

Approximate class size for that course:

Reading

1. How reading intensive do you consider this course?

4. Very much so 3. Somewhat 2. Not very 1. Not at all

2. How necessary is careful reading to success in the course?

4. Very much so 3. Somewhat 2. Not very 1. Not at all

3. How much time should successful students plan on reading per class meeting for this course?

a) more than 4 hours
b) 2-4 hours
c) 1-2 hours
d) less than 1 hour

4. What are the purposes of course readings? (check all that apply)

- serve as foundation for the course
- help students study for tests
- supplement instruction
- familiarize students with the discipline
- give students multiple perspectives

- other (please comment)

5. What kinds of materials do students read for your classes? (check all that apply)

- Text books
- Journal articles
- Primary sources
- handouts
- case studies
- newspaper/magazine articles
- surveys
- professional reports
- other (please comment)

Writing

6. How writing intensive do you consider this course?

4. Very much so 3. Somewhat 2. Not very 1. Not at all

7. Do students have to be good writers to pass the course?

4. Very much so 3. Somewhat 2. Not very 1. Not at all

8. Do you teach writing as part of this course?

4. Always 3. Sometimes 2. Occasionally 1. Never

9. What percentage of the course grade is based on writing assignments?

a) 75% or more

b) 50-74%

c) 25-49%

d) 24% or less

10. What are the purposes of writing assignments in this class? (check all that apply)

- demonstrate understanding of the content
- learn to become a better writer in the discipline
- other (please comment)

11. What kinds of writing do students do for your class? (check all that apply)

- Reflections/journals
- Reaction papers
- Reports
- Research papers
- compositions/essays
- other (please comment)

12. What kinds of writing do students do on tests? (check all that apply)

- Short answers
- Essays
- Bulleted lists or outlined answers
- Multiple choice
- Other (please comment)

13. What do you evaluate in student writing? (check all that apply)

- content
- language use
- structure/format
- other (please comment)

Appendix D: Example writing assignments

Example 1: Psychology 2040: Introduction to applied psychology

Current Event Summaries

Each student will complete THREE current event summaries worth 25 points each. Each student will turn in a 200 word summary of a NEWSPAPER or MAGAZINE ARTICLE (published during the past 12-months) that is relevant to a field of applied psychology that has been discussed in class. Students will be required to explain why this is a "real-life" example of an application of psychology. Students must cite examples from the lecture and/or readings and/or outside sources to support their explanation. Students must also provide a reference to the newspaper or magazine article in APA format.

Example 2: Psychology 3110: Interpersonal behavior

Film Assignment

Each student to need to view one of three films, *Talk to Her*, *Secrets and Lies*, or *Eternal Sunshine of the Spotless Mind* (all should be on reserve at the GSU Library). Next, the student will need to define in his/her own words and apply 2 large (or 1 large and 2 small) concepts or theories described in the text or in class to the relationships depicted in the film. You are also free to comment on aspects of the films that you enjoyed or that had an impact on you. If an assignment is turned in late (after 5 p.m. the day the paper is due) the student will lose 10% of their grade on their assignment. An additional 10% will be deducted for each day the paper is late. I do not accept papers by e-mail, if you turn in a paper by e-mail, I will deduct 10%. Length should be 3-5 pages (double spaced). You will receive a complete description of the paper at least 2 weeks before it is due.

This assignment is an independent project and must be in your own words. If 2 assignments are quite similar or if a student plagiarizes (presents someone else's work as their own, including phrases) a grade of 0 points will be earned even if you were unaware of your transgression. It is not acceptable to define the terms by placing parentheses around other scholars' definitions (you will earn 0 points for such definitions). Your best bet is to read a definition, shut the book and then write your own definition. Additionally, I prefer to be as objective as possible while evaluating your work, therefore, please do not put your name on your paper, instead use the initial of your last name and your student number as identification.

Example 1: Chemistry 3100: Practical organic chemistry

The midterm report will be 3-4 *typed*, double-spaced pages. It will focus on the acid extraction, isolation of caffeine and trimyristin, and the substitution reaction. The report should contain a brief description of the methods used in each experiment, the data: yields, physical properties, purification methods and spectra need to be included. It may be convenient to include an introduction, results and discussion,

and conclusion section for each experiment. Data are best presented in tabular form. Further details will be covered in lab lecture by the instructor. All experimental results MUST be presented along with appropriate literature values. All experimental procedures should also be adequately referenced.

The final report should be 3-5 *typed*, double-spaced pages. It should include a brief description of the method and approach used in purifying, separating and identifying the three unknown compounds, as well as a discussion of any particular problems or difficulties encountered and how they were solved. It should not include a detailed discussion of experimental methods as all of this should be in the note-book. The report should include (either within the body of the report or as an appendix) a tabulation of the boiling point, density, refractive index, results of chemical tests, major conclusions from IR data, da-ta on derivatives, the identity of the compound and any other relevant information.

Example 2: Chemistry 4000: Fundamentals of chemical analysis

Report 5

Again, many questions naturally arise during the course of this investigation: How can one establish that a M^{z+}_ligand interaction is happening? To what extent does the reaction proceed? When the ligands interact with $M^{z+}(L_1)_x$, are all the L_1 ligands displaced; furthermore, can the equilibrium constant for the process represented be determined from the titration data? If an acid, HA, is thought to be acting as a ligand, how can one determine which species, HA or A^- is L_2? Also remember that these two species are coupled by the equilibrium reaction: HA ⍰ A^- +

Keep these questions in mind as you investigate the titration of phosphoric acid with NaOH in the pres-ence and absence of Mg^{2+}. In your report you must answer these questions from your analysis of the titration data. In your report, you must identify the chemical processes occurring in the titration of phosphoric acid solutions based on your lab work, rather than merely state what is in the literature.

Summarize your results with phosphoric acid titrations with and without added Mg^{2+} in a formal report which is complete but concise as to experimental procedure. Which endpoint did you use in determin-ing your H_3PO_4 concentration? Why? Show representative titrations for solutions with and without added $MgSO_4$ on the same axes. Explain any differences in the two curves in light of the discussion pre-sented in Appendix V. Can you determine a binding constant for the complexation of magnesium and any species of phosphate during the titration? If so, identify the phosphate species you think is involved and justify your conclusion from your data.

Appendix E: Writing assignment classification

Writing assignments in lower division psychology courses

Course name/number	Types of writing	Language in prompts	Category	W
nat. science aspects of psychology/ 1100	5 tests (no description of question type)			**0**
Introduction to general psychology/ 1101	lecture notes (not graded), 4 m/c exams			**0**
introduction to applied psych/ 2040	4 m/c exams, 3 current event summaries, 1 group paper (and presentation)	current event summaries: "a 200 word summary of a newspaper or magazine article relevant to a field of applied psychology that has been discussed in class…explain why this is a "real-life" example of an application of psychology…cite examples from the lecture and/or readings and/or outside sources to support their explanation…provide a reference to the newspaper or magazine article in APA format. " Group paper: "…research a field of applied psychology that has been discussed in class…prepare a report that summarizes [the] research."	summary of / reaction to reading summary of / reaction to reading	**2**
Introduction to human sexuality/2070	note-taking (not assessed), 5 exams with m/c, matching, short answer, essay questions			**0**

Writing assignments in upper division psychology courses

Course name/number	Types of writing	Language in prompts	category	W
interpersonal behavior/3110	short answer questions on tests ,one 3-5 pg reaction paper	reaction paper: "…view one of three films (listed)… define …and apply 2 large concepts or theories described in the text or in class to the relationships depicted in the film."	connection of theory to data	**1**
Abnormal psychology/3140	3 m/c exams, 1 diagnostic impression report, extra credit reports	Diagnostic impression report: "…apply the knowledge you've acquired from lecture and assigned readings to developing a diagnostic impression of an individual whose case information will be provided to you…read/view the case details and construct a written diagnostic impression." extra credit: "… locate a news article directly relevant to a psychological disorder or topic covered in class and submit… a review of the article that (a) summarizes the topic…of the article, (b) relates the content to the course, and (c) critically evaluates the article for accuracy and/or sensitivity.	case study (optional) summary of / reaction to reading	**2**
introduction to research des & analysis/ 3510	online m/c quizzes, 7 tests with computations, short answer, fill in the blank, and essay questions			**0**
Advanced research des & analysis/ 3530 CTW	quizzes, 3 mixed exams (m/c , short answer ,fill in the blank) article worksheets, research proposal	article summaries: 1 page summary of required article, 1 page summary of article of student's choosing Research Proposal: "… a primary and secondary draft of each required section for the research proposal, including the GSU Informed Consent Form, Introduction and Literature Review, Method, and Analysis Plan."	summary of/reaction to a reading (2) research project	**3**
Social psychology/4020	3 m/c exams, 1 term paper	Term Paper: "….apply one or two social psychological concepts to a "real life" situation, another subject area, or a fictional work. In the first section of the paper, define [the] social psychological concept or concepts of interest.	connection of theory to data	**1**

		…summarize the results of…social psychology journal articles related to the concept(s) of interest. The second section should describe a situation or event to which the concept(s) apply. The third section of the paper should explain in detail how the concept…does or does not map onto the described situation or event."		
cognitive psychology/ 4100	4 exams, 3w's sheet in response to journal articles	3w's sheets: "The articles should be summarized by answering: What did the experimenter do? What did they find? What does it mean? "	summary of/reaction to a reading (2)	**1**
Theories of personality/4160	4 exams (m/c, short answer)			**0**
Environmental Psyc /4520	m/c exams, 1 scholarly article review, 1 design project, extra credit paper	Scholarly article review: "…read and write about one scholarly article in the published source literature in Environmental psychology and its connection to an article from the popular media." Design project: "students will prepare a scholarly paper based on their own design of a setting that meets the following criteria: 1) is aesthetically pleasing, 2) socially facilitative, and 3) safe."	connection of theory to data research project	**2**
psych of war CTW/4800	quizzes, two papers, two article summaries, one final paper	Paper 1: Write a 1 ½ page paper synthesizing two theories we have read about on the causes of war. You must demonstrate independent thought from our in-class discussions. Paper 2: Identical assignment to Paper 1 except the topic will be war's effects. Article Summaries: Summarize 2 *new* articles you intend to use for your final paper. Final Paper: Write a lit review of psychological theory about some aspect of war.	connection of theory to data summary of/reaction to a reading (2) synthesis of multiple sources	**3**

Writing assignments in lower division chemistry courses

Course name/number	Types of writing	Language in prompts	Category	W
survey of chem. I/ 1151 lab	pre-lab quizzes, 11 experimental summaries, measuring and recording data, post-lab ques-	Experimental Summaries: should not exceed one page. To be submitted prior to pre-lab	summary of/reaction to a reading	**1**

	tions and calculations, final exam			
survey of chem. II/ 1152K	5 m/c exams, lecture notes (not graded), chapter summaries (not graded), working problems in text (not graded)			**0**
survey of chem. II/ 1152K lab	11 summaries of experiments (pre-experiment), data report sheets, questions & calculations	Summaries of experiments: "…summary should include 1) the Purpose of the experiment and any relevant theory involved, 2) a brief overview of the experimental Procedure, 3) any special Supplies and/or Equipment to be used and 4) a Discussion of your conclusions and how you might interpret some of the data you obtain.	summary of/reaction to reading	**1**
gen chem. I/1211	9 quizzes, 4 tests, 1 m/c final online hw			**0**
1211 lab	10 pre-lab quizzes, lab note book, 10 data sheets, 1 formal comprehensive lab report	Final Report: The report should contain a brief introductionduction. The body of the report should state the procedures employed and the results. The conclusions and reasoning leading to them are the most important part of the final report.	report on specified participatory experience	**1**
gen chem.II/ 1212 lab	quizzes, lab notebook, final report, final exam, problem sets (ungraded)	Final Report: "…the final lab report consists of two sections; text and data tables. *Text*. 4-8 pages describing each of the major experiments, the significant final results for each, and a major section that presents in full detail the conclusions, deliberations, and calculations leading to these conclusions. This conclusion section should comprise at least one page…"	report on specified participatory experience	**1**
quant. analysis/ 2010	2 m/c exams, 1 final exam			**0**
organic chem. I/2400	4 exams, 1 final exam			**0**

Writing assignments in upper division chemistry courses

Course name/number	Types of writing	language in prompts	category	W
practical organic/ 3100	1 final exam, 1 final report, 1 midterm report, lab note book, 5 quizzes, 4 HW	Midterm report: The report should contain a brief description of the methods used in each experiment… It may be convenient to include an introduction, results and discussion, and conclusion section for each experiment. The final report: "…should include a brief description of the method and approach used…as well as a discussion of any particular problems or difficulties encountered and how they were solved."	report on specified participatory experience	**2**
organic chem. Lab II/ 3110	lab notebook, final exam, final report, quizzes	Final Report: The report should be to the point, well written and show your understanding of the material presented.	report on specified participatory experience	**2**
organic chem. II/ 3410	4 m/c exams, 1 m/c final exam			**0**
Fundamentals of chemical analysis/4000 (CTW)	3 exams, 1 final exam, 6 lab reports	Report 1: "Construct a conclusion on the question: are the original solutions the same? The conclusion must be based on a statistical analysis, and you must present your data and conclusions in a formal report." Report 2: "Construct a conclusion on the questions: are the original solutions the same? What are the estimated uncertainties for the relative concentrations calculated in this manner?" Report 3: "Write a formal report summarizing your work… Report 4: "Summarize…your method and analysis... Present the theoretical titration curve derived from your calculated values... Compare the literature value…to the one you determined from your titration data." Report 5: In your report you must answer [three questions pertaining to the experimental process] from your analysis of the titration data. Summarize your results [chemical process] in a formal report which is complete but concise...Show representative titrations for solutions…on the same axes. Explain any differences in the two curves in light of the discussion presented in Appendix V…identify the phosphate species…involved and justify your conclusion from your data. Report 6: Submit a report on this work that includes a description of the experimental results, the calculated concentrations for both [chemicals], the standard deviations, and why you chose the particular scheme…you must demonstrate your under-	report on a specified participatory experience	**3**

		standing of the [chemical]reaction.		
Physical chem. II/4120	HW problems (not graded), quizzes, ACS exam m/c, m/c final exam			**0**
spectroscopy/4190	lab notebook, 3 lab reports, 1 midterm exam, 1 final exam	Lab reports:The report should be organized into clearly defined sections that are easily located.	report on specified participatory experience	**2**